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A five-hour train service between New York and Boston has been inaugurated by the New York, New Haven & Hartford R. R., and will be continued daily, except Sundays, throughout the summer. The service will accommodate both ends of the route, a train leaving New York and Boston simultaneously.

The Trinity River, from Dallas, Tex., to the Gulf, is now being made navigable by private enterprise. Locks and dams will be put in at Dallas so as to make the river navigable at all stages, and the water stored will be available for water power for manufacturing purposes.

The contract for the cribwork bulkhead on the west side of Riker's Island, New York Harbor, has been awarded to Mr. Colin Campbell. About 3,000,000 cu. ft. of cribwork will be required and the contract price is $133,824. While the bulkheads are being constructed the spaces between the cribwork and the mainland will be used as a dumping ground, and by this means the area of the island will be considerably increased. The island will be used for municipal buildings when the work is completed.

A test of a 12-in. curved nickel-steel armor-plate was made at Bethlehem, Pa., on May 31, by the Chief of the Bureau of Ordnance, Commodore Sampson. The plate was 16½ ft. long, 6 ft. high and 12 ins. thick, and curved to an inside radius of 13 ft. 3 ins. Three shots were fired from an 8-in. gun. The charge for the first was 72 lbs. of powder, which created a velocity of 1,577 ft. a second. The penetration was 11¼ ins. The 250-lb. Holtzer projectile was slightly upset. It rebounded 50 ft. The second shot was fired with a charge of 90.3 lbs. of powder, developing a velocity of 1,826 ft. a second. The penetration was 15¼ ins. The rotating band was torn from the projectile, which rebounded the entire range of 250 ft. and fell beneath the gun platform. These two shots produced no cracks, and only a slight outward bulge on the back of the plate. Its acceptance was now assured, but the third and severest shot remained to determine the question of premium. The gun was loaded with 110 lbs. of powder, which drove the projectile into the plate at a velocity of 2,005 ft. a second. The projectile was broken into bits, which fell in a heap at the foot of the target. The plate was penetrated to its full thickness. The backing will have to be dug into to find the point of the projectile. If it cannot be found the Naval Board will award a premium to the Bethlehem Iron Company. The third shot produced no cracks, and the plate remained unscathed, except where the projectiles made clean-cut funnel-shaped holes. Upon the result of this test the acceptance of 472 tons depended.

A mammoth California redwood log has been prepared for the World's Columbian Exposition. The log from which the exhibit was shaped was 12 ft. long and 20 ft. in diameter at the butt, and weighed 129 tons. The only part shipped was the outside shell, 8 ins. thick. A solid log of redwood is also to be exhibited, 2 ft. thick and 15 ft. in diameter. The tree from which these pieces were taken was broken off 220 ft. from the ground, and was 9 ft. in diameter at the break. It is estimated that the tree was originally 417 ft. high.

The Cape Cod ship canal is to be taken up again by a Boston corporation, the Old Colony & Interior Construction Co. The officers elected on June 22 were: President, J. S. Anthony; Vice-President, W. H. Lincoln; Treasurer, R. L. Burnett; Chief Engineer, G. H. Titcomb. The new company is capitalized at $7,500,000; and the statement is made that Boston and New York bankers have subscribed $4,000,000 to the enterprise, a statement which does not appear very probable, considering the present condition of the money market.

The most serious railway accident of the week was a head collision June 17 on the Baltimore & Ohio R. R. in Big Broad Tree tunnel, near Cameron, W. Va. Both engines and 20 cars were wrecked and four men were killed. A bad collision of two extra trains occurred on the Kentucky Union Ry., near Clay City, Ky., last week, owing mainly to the duties of train dispatcher and agent at that place being entrusted to one man, who, being busy attending to his freight duties, forgot the extra trains.

A bridge on the Bedford & Bloomfield branch of the Louisville, New Albany & Chicago Ry., across White River, near Bloomfield, Ind., broke down under a freight train June 6. The entire train except the engine went into the river, and a brakeman was badly injured. This is the third accident of the kind which has happened at this point. An iron highway bridge over Rock River, at Crawfordsville, Ind., broke down on June 14 under a team of horses drawing a log. The bridge cost $30,000 several years ago. On June 16 a Howe truss bridge on the Central Vermont R. R., near West Berlin, Vt., caught fire from a passing train and was destroyed. A railway bridge near De Beque, Colo., on the Colorado Midland Ry., was burned June 20. A wooden bridge over Vermillion River, near Birmingham, O., broke down under a traction engine last week. An iron highway bridge over Grand River, near McFall, Mo., was wrecked by a storm on June 21.

One of the worst naval disasters for many years was the loss of the British battleship "Victoria" off the coast of Syria on June 22. The vessel was the flagship of the Mediterranean squadron, and was run into by the "Camperdown," one of the vessels of the squadron. The ram of the colliding vessel struck the "Victoria" on the forward quarter. The blow was apparently a glancing one, so that the hull was torn open and water was admitted into several of the compartments. The longitudinal bulkhead of the vessel, however, held the water to one side and prevented the vessel from settling evenly. She heeled over as the water poured in till the weight of the armament and top hamper capsized her. Of the 718 persons on board the vessel about 430 persons were lost. The accident may serve to call renewed attention to the effectiveness of the ram as a naval weapon. It has been somewhat lost sight of in the race after higher-power guns and better armor plate.

An unusually large dredge has been built for removing the bar at the mouth of the River Mersey, England. It is 320 ft. long, and its daily capacity is stated to be 24,000 tons.

Photometric tests of the electric arc lights used for street lighting in the city of Buffalo, N. Y., were recently made by Prof. Witthaus, Dr. F. P. Vandenbergh and Prof. J. E. Randall. The tests were made on three different makes of lamps, all rated at 2,000 c. p., and gave the following results:

	No. observations.	Av. c. p.	Max. series.	Min. series.
Thomson-Houston M. 2..	140	2,301.3	2,459	2,097.1
Wood	60	2,121.4	2,356.7	1,986.1
Brush	60	2,206	2,134.4	2,138.8

The lamps in these tests were all in the same circuit. In addition tests were made on lamps in five separate circuits, with from 51 to 58 lights each, showing candle powers varying from 2,191 to 2,784. The tests were made so as to gage faithfully the lights burned in the streets.

A system of rapid transit interesting from its novelty from an engineering standpoint, if not for its feasibility commercially, has been devised by an Italian engineer for the city of Naples. At present there is no satisfactory means of transit between the high level and low level sections of the city, and it is to provide this that the new line is projected. The line is to be carried on two metallic viaducts, each divided so as to form a double way, one for the operation of electric cars and the other for pedestrians. A masonry tower 325 ft. high is to be built in the Via Roma, and from this the first viaduct, 1,180 ft. long, will be carried to the Corso Vittorio Emmanuele, where it will terminate in the base of a metallic tower 490 ft. in height. The second viaduct, 950 ft. long and branching out of this tower some distance below the summit, will pass over the San Martino Hill and end in the ground level at the new Rione del Vomero. The viaducts will be carried on pyramidal metallic towers having masonry foundations; and the masonry tower at the beginning of the first viaduct and the metallic tower connecting the two viaducts will each be provided with staircases and capacious elevators for conveying passengers up and down. Passengers entering the cars at either end of the line will not be compelled to change their seats on arriving at the metallic tower, as the cars will be automatically placed on the lifts for ascending to or descending from the highest viaduct, when the cars will continue their way to either terminus. Generating stations will be provided at each terminus for producing current for lighting and power purposes. A concession has been granted for the road.

The Park Avenue improvement of the New York Central & Hudson River R. R., in New York city, illustrated and described in our issues of April 13 and May 25, has received a sudden interruption by the refusal of the city to pay its share of the cost up to date, on the plea of the unconstitutionality of the bill authorizing the expenditure. About $150,000 have now been expended on the work exclusive of the temporary bridge across the Harlem River, costing $60,000. It is not definitely decided whether the law is unconstitutional or not, but the present indications are that it will be held so, in which case there will probably be radical modifications in the plans for the improvements.

An oil well at Baku, in the petroleum district of Asiatic Caucasia, says "Herepath's Journal," has recently commenced to flow at the rate of 1,000,000 poods, or 17,742 tons, of crude oil in 24 hours. This exceeds the combined daily output of all the other large oil wells in that district; but, owing to the difficulty of getting a flow of this magnitude under control, most of the oil is now running to waste into an adjoining lake. In 1891 the total annual yield of oil in the United States was 54,291,980 barrels; or, taking an ordinary barrel of oil at 105 lbs., the daily average output for all the American wells was only 7,000 tons, or nearly 11,000 tons less than this alleged Russian spouter. It may be mentioned in this connection that the estimated flow of a well of this character, not under any control, is usually a case of guessing at the half and multiplying by two.

Marble equal to the best Carrara is stated to have been discovered in apparently large quantities at the Avondale quarries in Chester Co., Pa. A chemical and physical examination of some diamond drill cores made by Prof. J. F. Kemp, of the Columbia College School of Mines, New York city, is stated to have shown a crushing strength of 22,150 lbs. per sq. in., and from 0.052 of 1% to 0.0215 of 1% of absorption. These figures are so exceptionally good, as to make it seem doubtful if they are accurate indexes of the general character of the rock.

The Massachusetts State Board of Health has been authorized and directed to investigate and report on a metropolitan water supply to provide for the needs of Boston and its suburbs within a radius of 10 miles from the state house, and for such other cities and towns as in the opinion of the board should be included in the scheme. The investigation will be very comprehensive, including questions of protecting the purity of the supply and purifying the water. The board has power to employ engineering and other assistance and to expend $40,000 in the work, which amount has been appropriated by the state. The expense of the investigation will eventually be paid by the municipalities included in the plan finally recommended by the board. The report must be submitted to the legislature not later than the first Wednesday in January, 1895, and must be accompanied with drafts of bills intended to provide for carrying out the recommendations made. Mr. F. P. Stearns, M. Am. Soc. C. E., is engineer of the board. A population of about 900,000 is comprised within the limits of the proposed supply system.

The latest idea in submarine boats which has come to light as the result of the recent government advertisement for plans for a submarine naval boat involves the construction of a craft that can be sunk by admitting a limited quantity of water and will then run around on the bottom of the ocean on wheels. The inventor thinks that his boat can move more directly in a straight path than a boat subject to deflection by currents and waves, and therefore claims for her the ability to pick her position with accuracy beneath the ironclad she wishes to destroy. He has made provision for reaching the surface when desired by means of a set of pumps to expel the water admitted to the hull.

STEAM SHOVELS AND STEAM SHOVEL WORK.*

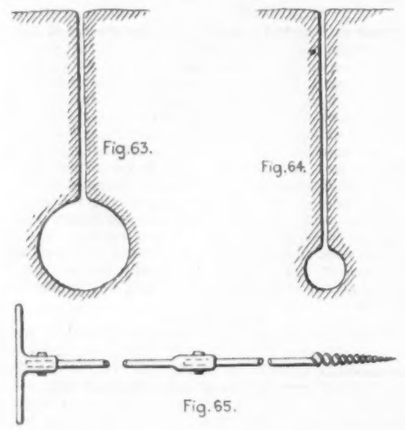
By E. A. Hermann, M. Am. Soc. C. E.

Part II.—Steam Shovel Work.

(Continued from page 562.)

Although the steam shovel is employed mostly on railway work, it is not exclusively a railway machine. It is already largely used on other work, and its use in this direction is rapidly extending, especially on the increasing number of extensive public works in the vicinity of large cities.

The most economical height of cut varies greatly with the nature of the material. In dry clay, loam and other dry materials which can be broken down readily with a bar or iron pointed pole (Fig. 17), cuts of 25 to 30 ft. in height are usually taken. In harder and more tenacious materials it should not exceed the height to which the dipper can be raised, 14 to 20 ft., varying with the size of the machine. In sand and loose gravel which easily falls down to the machine heights up to 60 ft. are common, and side-hill cuts in loose gravel up to 300 ft. in height have been taken. In such cases, and also in the removal of landslides, great care must be taken to avoid an avalanche of the material burying the machine when the toe of the slope is cut away. The pit track should always be kept close up to the sections of track under the steam shovel, so that it can be quickly withdrawn when necessary. As a general rule, the higher the cut the better, as the machine can then load the greatest amount of material between each advance,



and lose the least possible amount of time. Each forward move of the machine requires from three to ten minutes, depending upon the height of blocking, if any, it is working on; this is a dead loss, as no cars or wagons can be loaded during that interval.

Powder and dynamite are frequently used to good advantage to shatter the harder materials before excavating. When thus broken up about twice the amount of these materials can be loaded in a day. Great care must be exercised in the quantity of the explosive used, and in the location of the drill holes to prevent injury to the steam shovel. The explosives should be stored in a safe place, preferably in a vault at some distance from the place where they are to be used.

The use of dynamite is confined mostly to bowlders, ledges of rock and stumps of trees, while powder is generally used for hardpan, shale, slate, cemented gravel and hard clays. For the latter materials dynamite is usually too powerful, as instead of merely lifting and loosening them, as desired, it shatters shale and slate into fragments, and compresses the other materials about it, forming a "cistern" from 3 to 5 ft. in diameter, as shown in Fig. 63. Sometimes small quantities of it are used specially for this purpose to make room for a large charge of powder at the bottom of the drill hole, where its explosion will have the most effect in loosening the superincumbent material. A charge of one-quarter to one-half of an ordinary dynamite cartridge will usually blow out a "cistern" large enough to contain from one-half to one keg of powder, Fig. 64.

The depths of the drillholes in these materials vary from 4 to 20 ft.; they are made with a drill, or, in the softer materials, with an auger similar to a plank auger, generally about 2 ins. diameter, with extension pieces for deep holes, as shown in Fig. 65. Crowbars and wooden and iron wedges are also often used in breaking down overhanging material when it cannot quite be reached by the dipper.

The excavation of materials for which powder or dynamite are used to loosen them requires a powerful machine, with a strongly built, medium size dipper. A small or lightly built machine giving good satisfaction in soft materials would prove an utter failure here.

Assuming good management and a competent crew, the daily output of a steam shovel depends mostly upon the nature of the material excavated; it is also somewhat dependent upon the height and width of the face of the cutting, and largely upon the facilities for disposing of the loaded material, and keeping the machine almost constantly at work by an ample supply of empty cars and wagons. Although these varying conditions differ on each piece of work, the probable output of a machine for a given excavation can be closely estimated by good judgment based on previous experience with similar work. The average daily output in different kinds of materials, and under average, favorable and unfavorable, conditions, as described above, is shown in Table II.:

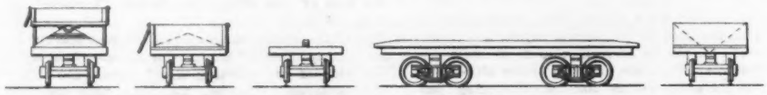
TABLE II.

Capacity of dipper.	Delay, hours.*		Sand. Cu. yds.	Loose gravel. Cu. yds.	Dry loam. Cu. yds.	Dry clay. Cu. yds.	Damp clay. Cu. yds.	Stiff blue clay. Cu. yds.	Loosened by explosives.—Hard pan, and boulders. Cu. yds.	Mixed clay rock. Cu. yds.	Loose Cemented gravel. Cu. yds.	Cu. yds.
2½ cu. yds.	1	Good...	2,400	2,400	2,050	1,800	1,200	800	600	600	440	600
"	5	Poor...	1,200	1,200	1,000	900	600	400	300	300	300	300
"	2½	Avg....	1,800	1,800	1,500	1,350	900	600	450	450	450	450
1¼ cu. yds.	1	Good...	1,600	1,600	1,200	1,000	800	600	400	400	400	400
"	5	Poor....	800	800	600	500	400	300	200	200	200	200
"	2½	Avg....	1,200	1,200	900	750	600	450	300	300	300	300
1 cu. yd.	1	Good...	1,000	1,000	800	700	500	400	300	300	300	300
"	5	Poor....	500	500	400	350	250	200	150	150	150	150
"	2½	Avg....	750	750	600	525	375	300	225	225	225	225

* The delay in hours is the time lost in moving forward and waiting for empty cars.

Part III.—Disposition of Material.

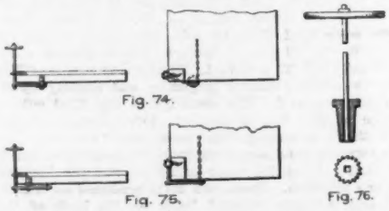
Loading the Material for Transportation.—The material excavated by a steam shovel is loaded on cars, wagons or carts. On railway work it is usually loaded on dump or flat cars. On other construction work small dump cars are most generally used, and sometimes wagons or carts.



Standard gage railway dump cars, Figs. 66 and 67, have nearly gone out of use. They were replaced by the center ridge flat car, Figs. 68 and 69, and it in turn has been replaced by the ordinary flat car. Dump cars are of two styles, dumping either by tipping, Fig. 66, or by means of a hinged sideboard opening on an inclined floor, Fig. 67. Both are heavy, clumsy, costly and can be used for scarcely any other purpose, often standing idle from six to eight months of the year. They dump dry materials very rapidly, but are often slow in discharging damp, tenacious materials, especially in the hinged sideboard car, whose floor slope is often not sufficient to permit the material to slip out quickly, and the material must then be pushed out, thus causing much delay. The greatest objection to these cars is that they can be used for scarcely any other purpose, on most railways for no other purpose; and there is not sufficient work for them to justify keeping the necessary number on hand for the ordinary work in this line. They were replaced by the center ridge car, Figs. 68 and 69, as above noted, which is merely an ordinary flat car with a timber 4×6 ins. bolted on its floor along the center line, serving as a guide for a plow, Fig. 70, drawn over it by the locomotive, thereby unloading the material. The ridge timber is slightly pointed at both ends to assist in guiding the plow onto the car as it passes from one car to another. The top edges of the ridge are sometimes protected by angle irons, as in Fig. 71, and the points by cast iron caps, Fig. 72. By taking off the center ridge this car can readily be restored to general service after completing the steam shovel work. The center dump car, shown in Fig. 73, is used only for gravel ballasting where the material is wanted delivered between the rails.

The brakes are placed on one side of the car, as shown in Figs. 74 and 75. When boulders, loose rock, etc., are to be unloaded, the brake staff is set in a socket, Fig. 76, and taken out before the plow is started. This avoids bending or breaking the staff in case any stone should be wedged between it and the moving plow. Sometimes the socket is used with the brake at its ordinary place at the end of the car; in such a case it must always be taken out before the plow reaches it.

The plow, Fig. 70, is built of heavy plate and angle iron, strongly braced, and headed by a cast steel point, to which the cable is attached. The sides are curved outward at the bottom, working under the material and pushing it aside as the plow is drawn along, and held down on the car by the weight of the material and the partly downward pull of the cable at its point. Short pieces of old rails and other scrap iron are also often placed on the plow to help hold it down on the car when very tenacious materials are to be unloaded. The groove extending along the center line on the bottom fits over the ridge timber on the car, and forms the guide by which its movement is directed. Small stones, protruding bolts, slivered ridge timbers and other obstructions in the groove of the plow sometimes wedge the point fast, and before the engine can be stopped, the plow is turned up on its point, and falling to either side, tumbles off the car. The weight and elasticity of the cable is often sufficient to draw the plow half a car-length after the engine has been stopped, and it is often difficult to stop the plow quick enough to prevent upsetting when obstructions occur, although the speed is usually only two to three miles per hour. The unloading nearly always occurs on trestles or embankments, and when the plow is thrown off the car, its replacement often requires much time and labor, sometimes even making the services of the wrecking car necessary. This difficulty is very likely to occur when unloading on curves, where one side of the point of the groove presses against the ridge timber. This plow unloads the material equally on both sides of the car, as it is wanted in filling trestles, raising embankments, tracks, etc.; but it cannot be used to advantage where the material is wanted on one side only, as in widening embankments for double track, sidetracks, yards, station grounds, etc.



The many objections to the center ridge car are almost entirely avoided by the use of the Barn-

*Copyright, 1893.

hart plow, Fig. 77, employing the ordinary flat car without any preparations except changing the brake staffs to one side or placing them in sockets at their ordinary places and inserting short stakes in the stake pockets, permitting the immediate use of the car for general service if necessity should so require. This plow is also built of heavy plate and angle irons, strongly braced, and headed by a cast steel point to which the cable is attached; it is preceded and followed by guiding sleds attached to it by adjustable hinges and guided over the car by the stakes in the stake pockets, which are indicated by the dotted lines. The usual speed at which it is drawn over the car is about four miles

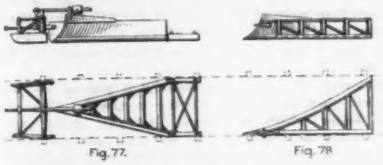


Fig. 77. Fig. 78.

per hour, but in loose gravel it can safely be drawn at a speed of six miles per hour. On straight track it is scarcely ever thrown off the car unless carelessly handled, and it works equally well on curves when the usual means are adopted to maintain a tangential pull of the cable, as will be subsequently described. Two styles of the Barnhart plow are in use: One unloading on both sides of the car, and called the center plow, Fig. 77; and the other unloading on one side only and called the side plow, Fig. 78.

(To be continued.)

NEW TUNNEL ON THE LONDON & NORTHWESTERN RAILWAY.

By Henry J. Bridgewater, Assoc. M. Inst. C. E.

About the largest tunnel in course of construction in England at the present time is that which is being made by the London & Northwestern Railway, between Marsden and Diggle, on its Leeds & Manchester Railway, and which was commenced in August, 1890. Increased traffic through this important woolen and cotton spinning district calling for additional means of transit, it was decided to double the existing accommodation of the two lines. The tunnel when finished will complete the widening of the ten miles of railway, seven miles of which have been executed. It passes through the Pennine Range, running northeast and southwest, is 16,032 ft. in length, and, with the exception of the two ends, is straight. Parallel to it are the two existing single-track tunnels, also a small canal tunnel, which runs between them and the new tunnel, the distance between the center lines of the canal tunnel and the new tunnel being 63 ft.

All the excavation is through a hard blue shale and grit stone, or, as it is locally known, Yoredale grit, from Yoredale, in Yorkshire, where the beds attain a thickness of from 800 to 1,000 ft. The quantity of the former to be gone through is about 90% of the whole, leaving 10% of the latter. The whole of the shale as well as the grit has to be removed by blasting. Gelignite is the explosive exclusively used. The existing single-track tunnels, running parallel with the new tunnel, very largely facilitated operations.

After numerous trials on nine successive Sundays, when traffic was entirely suspended, the center line of the existing down-track tunnel was determined, and this by means of 13 adits (which with one exception had previously been driven as far as the canal tunnel between the existing and new tunnels) was used as a base line for obtaining the working center line of the new tunnel, after the adits had been extended as far as was necessary.

The working center line having been decided, a bottom heading 9 ft. wide and 8 ft. high was driven, the rate of progress at each face averaging, the grit with the shale, 28½ lin. ft. per week with 27 faces worked day and night, and an average of two drills to each face. The debris taken through the 13 adits was tipped into and removed by canal boats fitted with 10 skips apiece, each holding 1½ cu. yds.

Shifts of eight hours each, including a lunch-time of a half hour, were worked without a break by the miners until the middle of April, 1892, when they were altered to 11 hours, of which the men work 10 hours, leaving a break of one hour between each shift. This alteration was occasioned by the admittance through the completed heading of sufficient fresh air to keep the workings from getting too foul.

During the driving of the bottom heading it was found necessary to employ two 500-HP. air compressor engines to ventilate the faces of the headings, which, owing to smoke which found its way from the existing tunnels through the adits, combined with the fumes occasioned by firing, became very foul.

The size of the main pipes which were laid in the existing down-track tunnel and conveyed the air from the engines varied from 8 ins. diameter at the receiver to 6 ins. diameter at a distance of one and a half miles, this being the maximum distance, plus the lengths of the headings, supplied by each engine. The cross pipes, which were taken through the 13 adits, and transmitted the air along the headings to the faces, were 3 ins. diameter. On the completion of the bottom heading, sufficient ventilation being afforded by the open ends, the artificial supply was cut off.

The following are a few of the leading details of the above mentioned machinery: Diameter of steam cylinder, 18 ins.; stroke, 3 ft.; diameter of air cylinder, 27 ins.; stroke, 3 ft.; two inlet and two outlet mushroom valves; diameter of delivering air pipe, 7 ins.; number of revolutions per minute, about 50. These engines were worked by three locomotive boilers.

Light iron Decauville dump cars holding 1 cu. yd. were used in making the bottom heading, and are principally used at the present time inside the tunnel and solely for taking the spoil up the shafts.

Ordinary 3-yd. cars, drawn by locomotives, are used for taking the excavated material to the spoil grounds for a distance of about a half mile at each end of the works, the tracks being laid along the canal tow-path.

The position of 40 break-ups having been determined, of which, however, only 35 were worked, the opening out, including the two open ends, was carried on at 72 faces, with an average of four drills to each face. Generally the tunnel is being constructed in 15 ft. lengths, but, where junction lengths and the grit stone occur, they have been increased to as much as 32 ft.

Little water being met with, combined with the generally homogeneous nature of the rock, necessitated no unusual timbering. In some cases lengths of 30 ft. have been completely opened out in the grit stone without any timbering whatever having to be resorted to, and in many instances the shale only required six drawing and no taking out bars. The arch ribs forming the centering are of skeleton type and made of elm; one double leading and two single intermediate ribs being used in a 15-ft. length.

The rate of progress in opening out and lining the tunnel complete is at the present time about 900 ft. per month. This quantity will necessarily be reduced as junctions are made and there are fewer faces working, but at the present time new break-ups are being started with a view to push forward the rock as rapidly as possible, and efforts are being made to complete the tunnel by the end of the present year.

Fig. 1 shows the average cross-section of the tunnel. In some instances, where the grit stone occurs, the brickwork has been reduced to 1 ft. 2 ins. in thickness, while where the shale beds appear broken and shaky five half-brick rings have been put in. It has been decided to omit the sidewalls through the gritstone, as shown on the left, when the beds lay horizontally, but in every case the roof is to be lined.

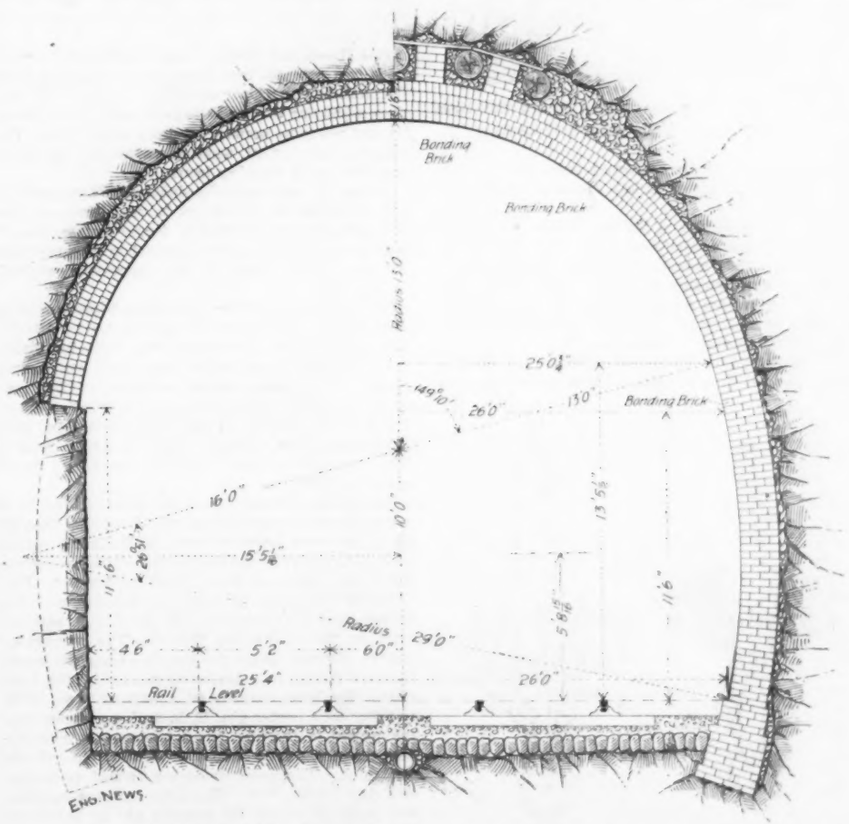


FIG. 1. CROSS SECTIONS OF NEW TUNNEL ; LONDON & NORTHWESTERN RAILWAY.

It will be seen on the right of Fig. 1 that the portion having a radius of 13 ft. is in five places bonded by specially molded bricks, 1 ft. 2 ins. long. Splayed bricks, also specially made, were intended to carry stone tops to side drains which have, however, since been superseded by a central drain composed of Doulton's 9-in. earthenware "Opercular" pipes emptying into the canal by means of cross drains taken through the 13 adits.

The lining is composed wholly of brickwork, faced with brindled bricks, and laid in hydraulic lime mortar, the ingredients and their relative proportions being lime 1 part, sand 1½ parts, and ground mill ashes 1½ parts.

The backing is of broken rock, hand packed, and

set in mortar similar to that used for the brickwork. Recesses constructed in the sidewalls to afford shelter to platelayers (trackmen) and others during the passage of trains, occur every 132 ft. alternately on the opposite sides of the tunnel.

Larch trees have been used for crown bars in about one-half of the lengths already turned. In the remainder, rail crown bars, Fig. 2, consisting of two steel track rails, which had been removed, owing to wear, from the railway company's main tracks, and weighing about 75 lbs. per yd., have been adopted, a method suggested by Mr. A. A. Macgregor, Assoc. M. Inst. C. E., the Resident Engineer in charge of the works, with very satisfactory results. Although the cost of these bars is about the same as of the larch trees, they present many good qualities, and are a saving in cost as compared with the others, being easier of manipulation and also necessitating less excavation and backing. Several tests made of the

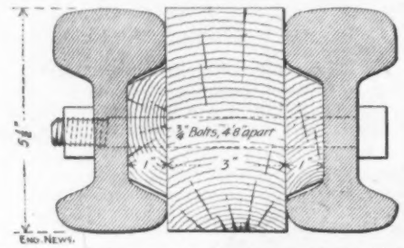


Fig. 2. Tunnel Crown Bars made of old Bull-Head Rails; London & Northwestern Railway.

strength of these bars showed them to be equal to round larch bars of 11 ins. diameter under similar conditions.

The chief objection to the use of rail bars is that their maximum deflection is about half that of the larch bars, thus making them somewhat treacherous, and necessitating a careful watch being kept by the excavators against undue stress. Haulage is done by engine power where possible; in other cases horse power is employed.

With regard to the disposal of the rock to spoil, it was intended that the bulk of it should be hoisted

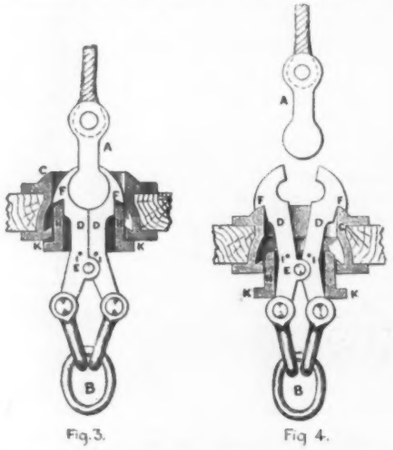


Fig. 3. Fig. 4.

Fig. 3 and 4. Walkers Detaching Hook to prevent Over-Winding of Cages.

up three shafts which were commenced at the same time as the bottom heading, and which were expected to be completed by the time the heading had been driven its entire length. The position of all the shafts are directly over the canal tunnel and 63 ft. distant from the center line of the new railway tunnel. Unfortunately, however, large quantities of water had to be contended with in two of the shafts. In the first case, namely, at Flint shaft, when sinking operations had reached a depth of 195 ft. a spring of water was tapped which necessitated either mechanical power for lifting it, or, as was adopted, the sinking of a 15-in. bore hole through the remaining 303 ft. of rock, thus tapping the water and allowing the sinking of the shaft being proceeded with. Two months was the estimated time for completing the bore hole, but the actual time taken was nearly five and a half months. The sinking and lining with brickwork of this shaft after the borehole was completed occupied almost four and a half months. The proportions of shale and grit stone excavated in the last 303 lin. ft. were 30% and 70%, respectively.

In the second case, namely, at Brunn Clough shaft, after 84 ft. had been sunk and lined so much water was met with that it was decided to abandon operations, and instead to widen the existing shaft of 10 ft. diameter to 20 ft. diameter. The time occupied in doing this was seven and a half months, 75 % of the excavation being shale and 25% grit stone. The depth of this shaft is 420 ft.

The third, or Red Brook shaft, which is 513 ft. deep, presented but little difficulty, being comparatively free from water. The proportions of shale and grit stone were 40% of the former and 60% of the latter. Several coal seams, varying in thickness from 2 ins. to 8 ins., were met with in sinking Flint and Red Brook shafts.

All the shafts are circular, the internal dimensions of Flint and Red Brook shafts when lined being 18 ft., and 20 ft. in the case of Brunn Clough. In each instance the lining is of brickwork, varying from 14 ins. to 18 ins. in thickness, faced with brindled bricks, and set in hydraulic lime mortar.

Red Brook and Brunn Clough shafts are provided with two wrought iron cages, each weighing 2,156 lbs., and having a floor area of 10 ft. × 5 ft. 10 ins., thus admitting of two Decauville cars being drawn up and the same number let down at one time. The greatest number of wagons wound up one shaft was 635 in 22 working hours.

Owing to the delay in the sinking of Flint shaft, the excavating of the break-ups in the vicinity of this pit had advanced to such a degree by the time it was completed that it was decided to dispense with the use of the shaft for the purpose of winding up the spoil.

The winding up of the excavation is performed at Red Brook and Brunn Clough shafts by 30-HP. (nominal) Robey mining engines, built by Robey & Co., of Lincoln, and which have given entire satisfaction. The diameter of cylinder is 12½ ins.; stroke of piston, 18 ins.; diameter of winding drum, 7 ft.; width of drum, 3 ft., in two 1-ft. 6-in. compartments. The average speed of lifting rope is 500 ft. per minute. Lifting capacity (gross weight), 9,184 lbs.

The winding ropes, which are of steel, and have a guaranteed breaking strength of not less than 38 tons, are each provided with a Walker's patent detaching hook for the prevention of the over-winding of the cages, as shown in Figs. 3 and 4. Fig. 3 shows the hook previous to detachment. The lifting rope is attached to the shackle A and the cage to the connecting link B. The supporting ring C, through which the rope is constantly working, is a fixture in a bearer at the top of the head gear. The hook consists of a pair of jaws, D D, working on a center pin, E, in such a manner that the weight of the load has a tendency to open the upper limbs which clip the center pin of the shackel A. The upper limbs are formed externally with jaw hooks, F F. The jaws are kept together and made to retain the shackle pin by means of the clamp, H, which is held in position by the pins, I I.

In case of overwinding, the jaw hooks (held together by the clamp) pass freely into the ring, C, but the projections, K K, of the clamp coming into contact with the bottom flange of the said ring hold the clamp stationary while the jaws are being pulled through, the result being that the pins I I are sheared off and the jaw hooks released from the restraint of the clamp. The internal diameter of the ring being the same as the width across the jaw hooks, F F, the rope remains secure until the jaw hooks reach the top of the ring, when, by the action of the weight of the load they are forced open and so hook on to the top of the supporting ring, C, as shown by Fig. 4, the rope passing over the pulley.

A twofold reliance can be placed on the efficient working of the jaw hooks, F F, e. g.: Suppose that the load did not force open the jaws, the bottom flange of the ring would then press the clamp against the incline of the limbs, thereby causing the jaws to open and the jaw hooks to act. One case of over-winding has occurred on these works when the detaching hooks answered satisfactorily, no damage whatever resulting.

Up to the present time 9,411 ft. of tunnel have been completed, leaving 6,621 ft. to be done. The number of men employed inside the tunnel is about 1,400, and on the outside works, comprising tunnel approaches, tips, etc., about 150.

THE PURIFICATION OF WATER BY FREEZING.*

By Prof. Thomas M. Drown.

The rapid growth of the artificial ice industry, and the claim frequently made that artificial ice is much purer than natural ice, make it desirable that the relation between the quality of ice, and the quality of the water from which it is formed should be fully understood.

Freezing of water is ordinarily a process of purification, that is to say, the ice is usually purer than the water which is frozen. And yet, under certain conditions of freezing, the ice may contain the impurities of water in a highly concentrated condition.

The purification of water by freezing can be best observed in nature, when ice is formed slowly on deep ponds in winter. Laboratory experiments on the freezing of water containing known amounts of various substances in solution, are generally less satisfactory because the abstraction of the heat of the water by freezing mixtures is usually very rapid, and also because the amount of water experimented with is comparatively small.

In the formation of ice on deep ponds in winter it is the surface only that is affected, and the rate of freezing decreases as the ice increases in thickness. The water freezes very slowly after the ice is a few inches or more in thickness, and it is under these conditions that the greatest purification—that is to say, the most perfect elimination of the substances in solution in the water—takes place.

The State Board of Health of Massachusetts made a few years ago, a very thorough investigation of the ice supplies of the State,* and many interesting facts with regard to the purification of water by freezing were then determined.

A sample of ice from an unpolluted pond was found to be purer than most distilled water; it had no color, it was free from free and albuminoid ammonia and nitrites, and contained only 0.2 part of mineral matter per 100,000 (0.01 grain per gallon), and 0.005 part of nitrogen as nitrates. This ice was formed from water which had 3.15 parts of mineral matter, 0.0192 part of albuminoid ammonia, 0.44 part of chlorine, and 0.01 part of nitrates. Among the 275 analyses of ice and water made in the course of this investigation, there are many instances where the degree of purification was as great as the one cited. In as many cases as possible the comparison of the water and ice was made by cutting out a piece of ice from the pond and then taking a sample of water from the opening made in the ice. Where ice harvesting was in progress corresponding samples of water and ice were easily obtained. The following table contains the average composition of 10 samples of water and the corresponding 10 samples of ice. In each case the water and ice were collected at the same time as above described. Some of the ponds and rivers included in these averages were unpolluted, but the majority of them contained considerable sewage or the drainage of houses or stables. The determinations were made on the melted ice after filtering through paper and resulted as follows:

	Averages, parts per 100,000.						
	Color.	Fixed residue.	Free ammonia.	Albuminoid ammonia.	Chlorine.	Nitrogen as Nitrates.	Nitrites.
Water...	0.3	6.075	.00864	.0135	.617	.0430	.0006
Ice.....	0.0	.391	.00112	.00108	.040	.00430	.00003
Pr'c'tage remaining in ice.....	.0	6.4	13.	8	1.6	10.	

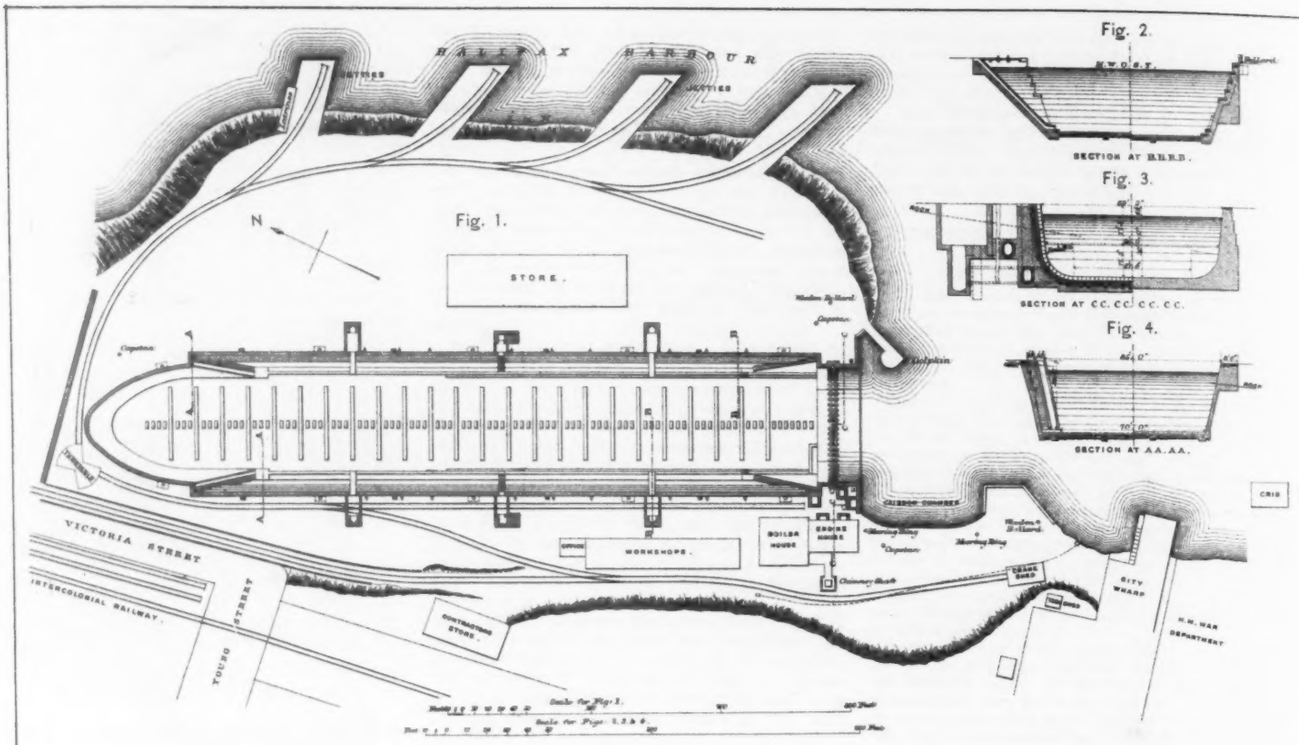
In the above cases the comparison is made between the water and the whole mass of ice. A comparison between the water and the bottom portion of the ice would generally show a still higher purification. It is not at all uncommon, in the bottom ice, to find free and albuminoid ammonia and chlorine entirely absent. This is not often the case in the top ice, and snow ice is generally quite impure.

Progressive improvement in the quality of the ice from the top downward has been shown by analysis of a block of ice which was divided into five layers.

We may fairly conclude from the above that the degree of purification in freezing is dependent on the

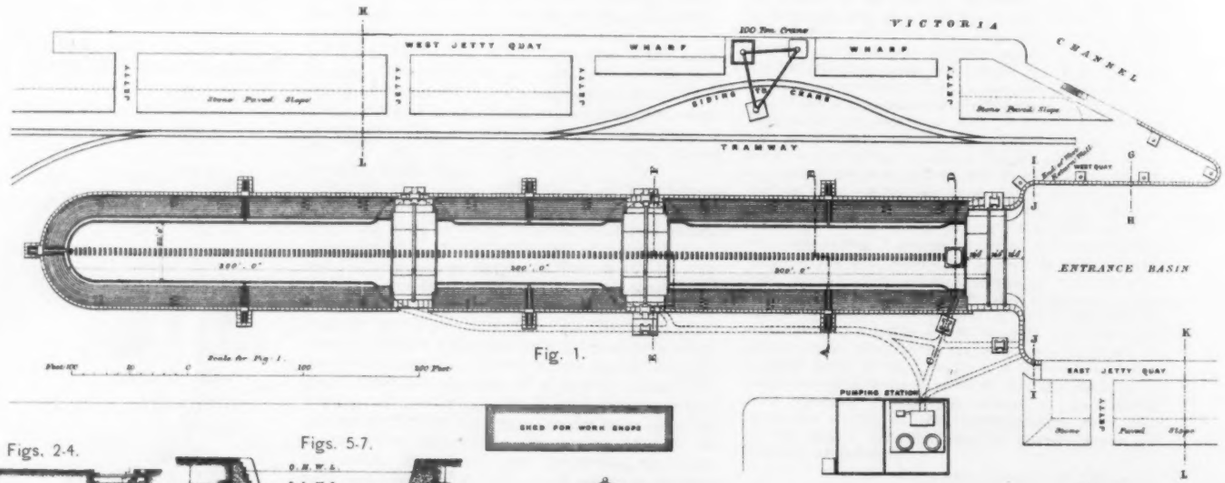
*Abstract of a paper read before the Annual Meeting of the New England Water-Works Association, June 15, 1893. This paper, with discussions, will be published in full in the Journal of the New England Water-Works Association.

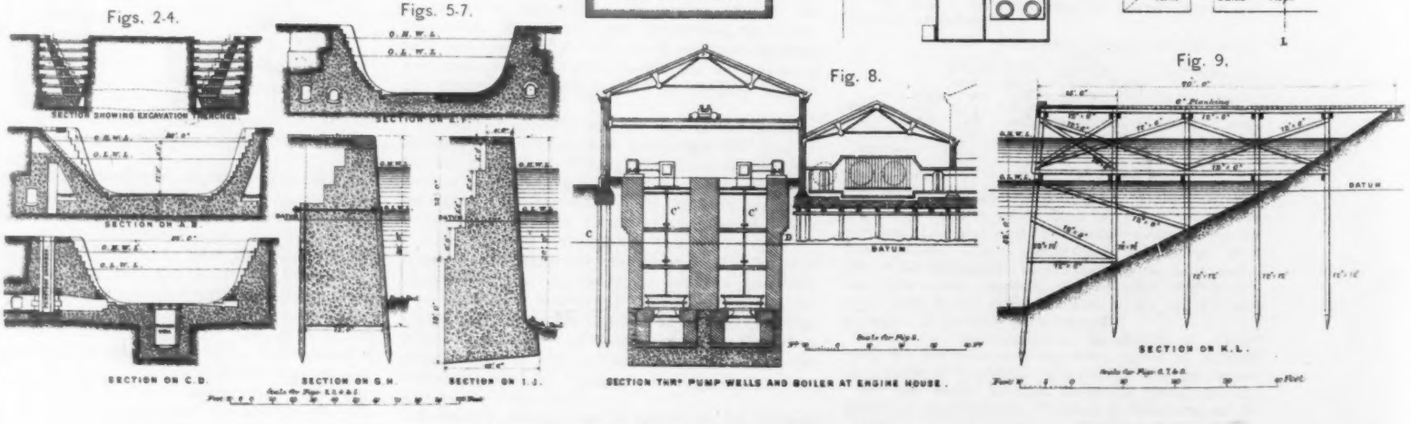
*Twenty-first Annual Report, pp. 143-223.



Halifax Graving Dock, Nova Scotia.

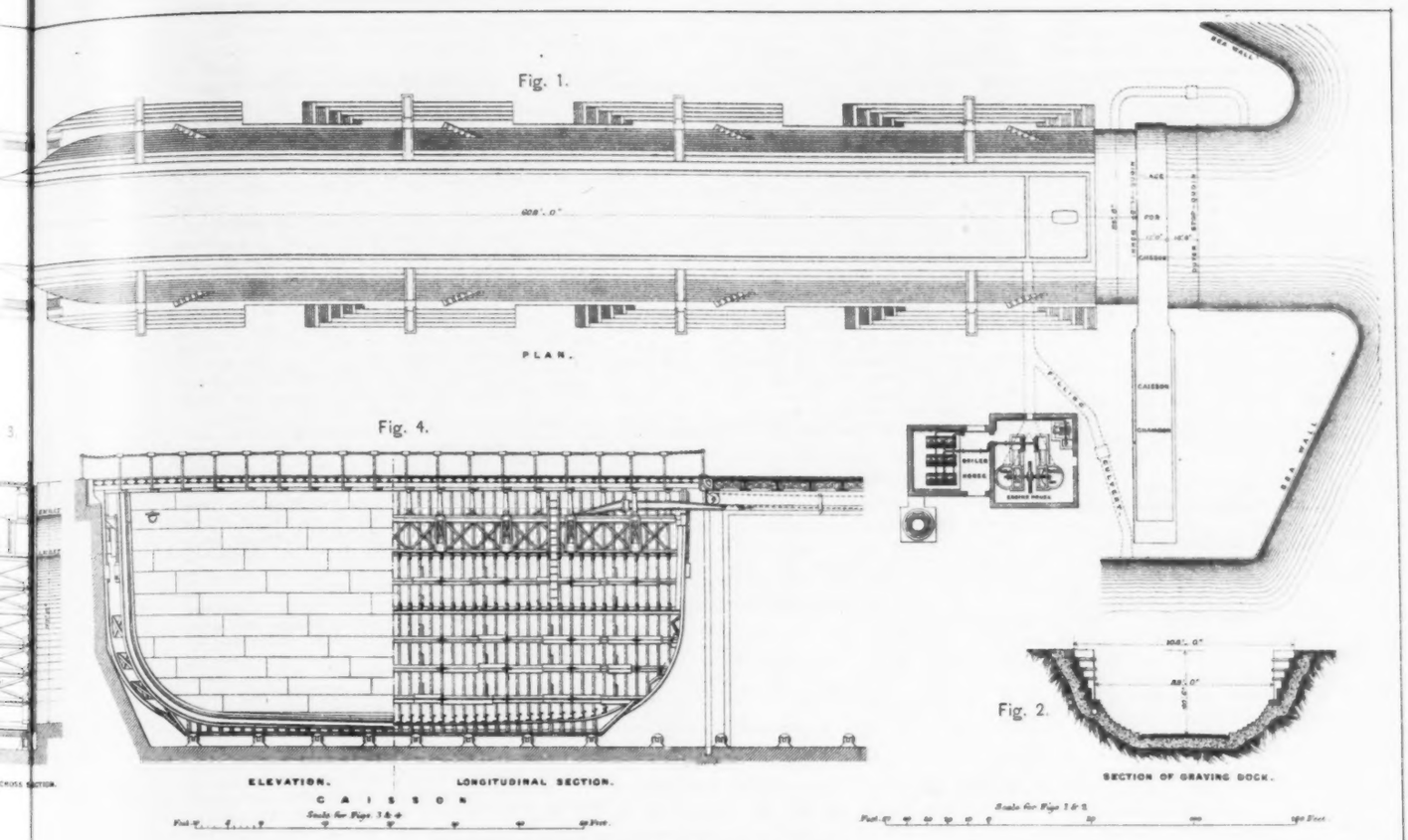
J. F. LA TROBE BATEMAN, M. Inst. C. E., Designing Engineer.





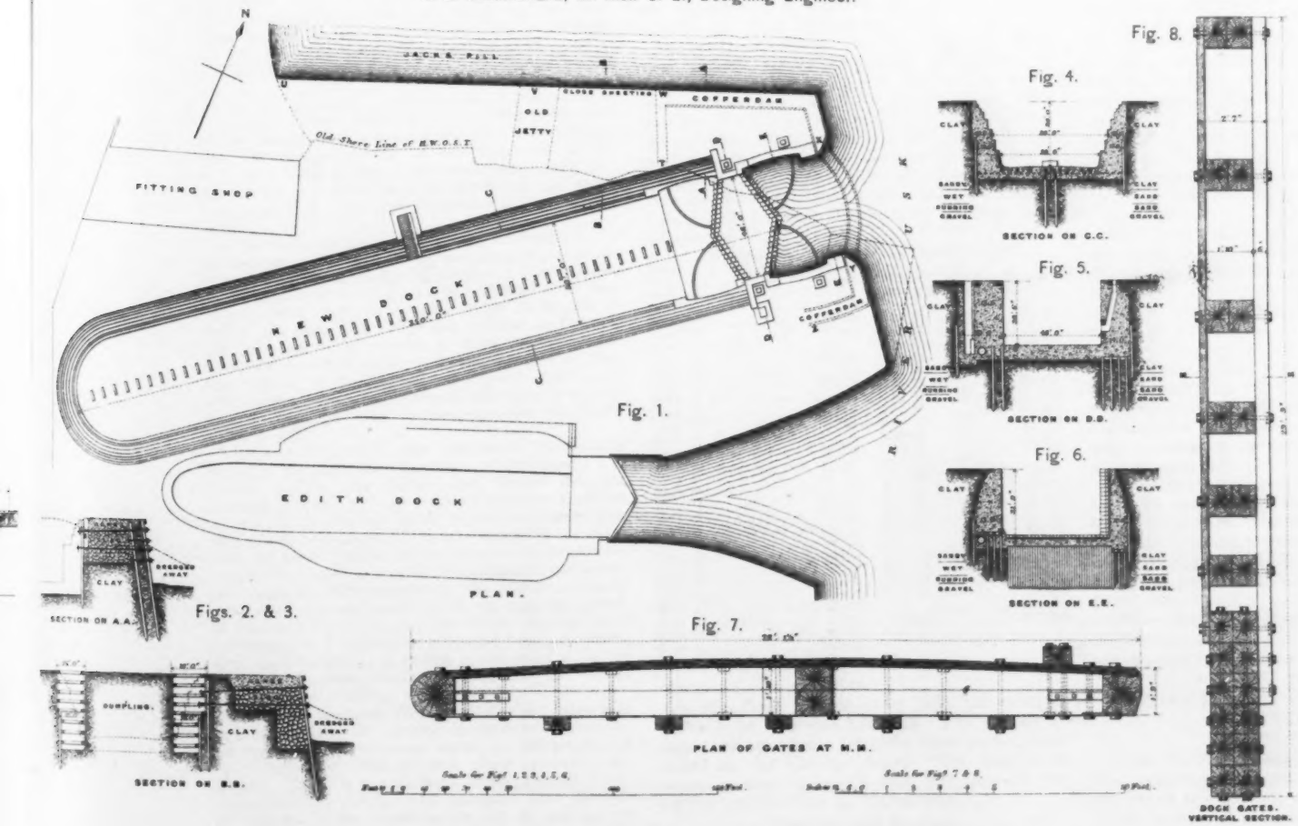
Alexandra Graving Dock, Belfast, Ireland.

THOS. R. SALMOND, M. Inst. C. E., Chief Engineer. Wm. R. Kelly, M. Inst. C. E., Assistant Engineer.



Biloela Graving Dock, Sydney, N. S. W.

J. B. MACKENZIE, M. Inst. C. E., Designing Engineer.



Concrete Graving Dock, Newport, England.

ROBERT PICKWELL, Assoc. M. Inst. C. E., Designing Engineer.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

rate, the slower the process the more complete the elimination of the dissolved and suspended matter in the water.

When ice is forming quickly the suspended matter in the water is probably entangled to a greater or less extent in the ice crystals. In a case in which a body of sewage was frozen to a depth of 1 in. the ice contained only 5% of the dissolved organic matter (as indicated by the determination of the albuminoid ammonia), while it held 28% of that which was in suspension.

As regards the bacteria there is also progressive improvement in the quality of the ice from above downward, as might be expected. The bacteria determination made in connection with the chemical analyses in these investigations showed that the snow ice contained as many as 81% of the bacteria of the water, and the clear bottom ice only 2%. This large removal of bacteria may, of course, be partly due to their destruction by long-continued cold, but the researches of Dr. Prudden, Dr. Billings and others have shown that many specific organisms resist the action of cold for a very long time.

The greater impurity of the top ice may be due to various causes. The ice first formed on a surface of water, more or less ruffled by the wind will inclose, doubtless, more of the impurities of the water than when freezing goes on more slowly and quietly. Again, the surface of the ice may be flooded by the water from below; this is often intentionally done by ice cutters. When this water is frozen solid there is, of course, no opportunity for the elimination of dissolved matter. Further, the dust and dirt of various kinds which fall on the ice, especially on ponds near cities, the impurities which snow brings down out of the atmosphere, and the contamination of the surface by men and horses at the time of ice cutting, all contribute to render the surface ice impure.

The elimination of water, when it freezes, is necessarily accompanied by a concentration of the impurities in the water itself.

When a shallow pond freezes to the bottom it is evident that the ice last formed must contain the greater part of the impurities of the whole body of water. So great is the tendency to purification in freezing that it is in the lower few inches of ice that one must expect to find the greater part of the impurities in cases where the whole body of water is frozen solid.

A not uncommon practice in places where there are no natural ponds is to flood low ground before cold weather comes on in order to gather an ice crop When such a shallow pond freezes solid the organic matter, which the water has soaked out of the ground, may be in a highly concentrated state in the bottom ice.

It is not improbable that in some of the cases in which ice has been known to be the cause of sickness that it was cut from shallow ponds with dirty bottoms. The well known epidemic at Rye Beach, N. H., in 1875, is a case in point. The ice which caused the the trouble was cut from a flooded marsh, the water being only 2 ft. deep and containing a good deal of sawdust.

In the ordinary process of making artificial ice the whole mass of water is frozen, and consequently if the water used is not pure we must expect a concentration of the impurities in the portion last frozen. Large cans of galvanized iron, of a capacity of 200 to 250 lbs. of water, are filled with water and exposed on the outside to a circulating solution of brine which is cooled below the freezing point of water. About two days are required to freeze this quantity of water to a solid block. The ice first forms on the sides of the can and gradually increases in thickness until the whole mass is solid.

I have recently made some analyses of blocks thus frozen to determine the distribution of the mineral and organic matter. The blocks were divided into six portions, namely, an upper, middle and lower portion of the outside, and an upper, middle and lower portion of the interior core. It was found in all cases that the lower portion of the core of the block contained the greater part of the impurities of the water. One would naturally suppose that the middle and upper portions of the core would contain the greatest amount of the impurities (as in the case of the segregation of the impurities in the cooling of a steel ingot), but there were some conditions of cooling in the cases of the ice blocks which determined the portion near the bottom to be the last frozen.

Samples of ice made from distilled water have also been examined. The amount of dissolved matter in distilled water is extremely small, yet the process of concentration is, even in such cases, generally noticeable. Thus, in one instance where distilled water was frozen the chlorine was increased from .02 part per 100,000 in the water to .33 part in one portion of the ice.

From the above we may conclude that the claim for purification by freezing can only be admitted when a portion only of a mass of water is converted into ice. When a body of water is completely frozen, whether in a pond or in a can, the ice as a whole has the same composition as the water itself. Under these conditions the impurities cannot be eliminated, but they are re-distributed, the ice first formed being very pure, and that last formed containing nearly all the impurities.

In deep ponds we find the ice to be of high purity, even when the water itself is quite impure. In shallow bodies of water we should have very pure water and clean ground if the ice is to be above suspicion. In the case of artificial ice it is absolutely necessary that the water should be of the highest purity. It would be seldom that a well or spring water could be found which would not give an objectionable degree of concentration of mineral matter in the portion last frozen. Distilled water leaves nothing to be desired as regards purity, and the manufacturers of artificial ice will find it desirable to limit themselves to its use.

In all the cases of artificial ice which I examined there were practically no bacteria in the water used or in the ice. It is the general practice in making artificial ice to boil the water in order to expel the air, otherwise the ice block would be very porous from air bubbles and would look more like a cake of compact snow.

WORLD'S COLUMBIAN EXPOSITION.—XV.

Electricity Building.

This building was described and illustrated in detail in our issue of May 11, and we have since received from Mr. E. C. Shankland, Chief Engineer of the World's Columbian Exposition, the following particulars of contracts and cost, etc.:

Carpentry and ironwork	4,800,000 ft. B. M. / 1,229,564 lbs.	$292,624
Exterior covering	215,000 sq. ft.	85,000
Painting and glazing (glazing,	423 squares)	6,523
Lathing and plastering	140,000 sq. ft.	6,000
Roofing, sheet metal and skylights: roofing	240,000 sq. ft.	22,100
skylights	55,000 sq. ft.	
Sculpture and decoration		22,115
Miscellaneous		4,538
Total cost of completed building		$438,900
Total area of floor		260,000 sq. ft.
Total area of gallery		158,000 sq. ft

The contractors for the several description of work were as follows: Carpentry and ironwork, A. Johnson & Co.; exterior covering, J. Griffiths; painting and glazing, W. P. Nelson & Co.; lathing and plastering, J. Griffiths; roofing, sheet metal and skylights, J. A. Miller & Bro.

Attendance.

The daily attendance thus far has been much greater than at the Centennial Exposition, at Philadelphia, in 1876. It falls considerably below the attendance at the Paris Exposition in 1889, however, but it must be remembered that the nominal admission fee at Paris was but one franc (20 cts.), and that the actual price, owing to discount, was only about 10 cts., while at Chicago it is 50 cts. The following table of attendance at Chicago during May has been furnished by the Bureau of Admissions:

Chicago, 1893.		Philadelphia, 1876.	
May 1	137,557		
May 2	19,524	(The Centennial Exposition opened on May 10.)	
May 3	28,607		
May 4	24,168		
May 5	20,761	May 10	76,172
May 6	28,860	May 11	14,722
May 7, Sunday		May 12	10,252
May 8	36,689	May 13	11,658
May 9	28,455	May 14, Sunday	
May 10	33,153	May 15	10,896
May 11	25,261	May 16	7,656
May 12	30,929	May 17	12,117
May 13	62,099	May 18	11,054
May 14, Sunday		May 19	16,100
May 15	37,532	May 20	12,402
May 16	38,552	May 21, Sunday	
May 17	52,161	May 22	20,871
May 18	51,450	May 23	25,678
May 19	48,518	May 24	30,190
May 20	78,643	May 25	27,156
May 21, Sunday		May 26	24,119
May 22	53,376	May 27	27,710
May 23	50,346	May 28, Sunday	
May 24	67,179	May 29	23,467
May 25	61,386	May 30	35,163
May 26	55,058	May 31	30,876
May 27	92,376		
May 28, Sunday	94,830	Total	497,659
May 29	61,462		
May 30	139,979		
May 31	63,058		
Total	1,516,369		

At the Paris Exposition of 1889 the total attendance for May was 2,610,813. This number included the attendance for three Sundays not represented in the Chicago figures. The number of visitors at Chicago for the time May 10 to 31 was 768,989 greater than at Philadelphia.

Expenses and Receipts.

Several incorrect statements of the financial affairs of the Exposition having been made by some Chicago daily papers, the following official letter on the matter has been issued by Mr. William K. Ackerman, Auditor, and Mr. Ferdinand W. Peck, Chairman of the Finance Committee:

The recent statement published in some of the daily papers regarding World's Fair finances are grossly misleading. The entire expenses of the Exposition for May, including pay rolls, were $250,000 less than the amount published as the pay rolls alone. The total expenses for May were less than $600,000, or about $19,400 per day, and the total receipts were $720,000, the Exposition being open but 27 days. These expenses were much larger than they will be in June or thereafter, owing to the then unfinished condition of grounds and buildings and the work of installation, which is now finished. The expenses are being largely reduced every day. The receipts for May include very small returns from concessions, the operations of which had hardly begun. The average revenue from admissions and collections thus far this month exceeds $55,000 per day. The daily receipts from both these sources, especially the latter, are constantly increasing largely. The admissions at the Philadelphia Centennial Exposition for the month of October were nearly three and one-half times as great as in the month of June. This brief official publication should be given publicity, as the effect of the recent publications is very unfortunate.

Previous International Expositions.

The World's Columbian Exposition is the ninth of a series of great expositions which commenced in London in 1851, as noted in our issue of Jan. 30, 1893, and we give below some general statistics showing the comparative importance of these expositions:

1851.—The first great international exposition was held at London in 1851. It lasted 144 days; the buildings and grounds covered 21 acres; there were 17,000 exhibitors and 6,039,195 visitors; 41,933 daily. The receipts were $2,530,000, and the expenses $1,460,000.

1855.—The second exposition was held at Paris. It continued 200 days and covered 24½ acres. There were 21,779 exhibitors and 5,162,330 visitors; 25,811 a day. The cost is conjecturally stated at $1,700,000; the receipts were $1,280,000.

1862.—The third exposition was held in London in 1862. It continued 171 days and covered 23½ acres of ground. There were 28,653 exhibitors and 6,211,103 visitors, a daily average of 36,325. It cost $2,300,000, and the receipts were $2,040,000.

1867.—The fourth was in Paris in 1867. It covered 37 acres and continued 217 days. The exhibitors numbered 50,236, and the visitors 10,200,000; 47,470 daily. The cost was $4,000,000; the receipts were $2,100,000.

1873.—The fifth was held in Vienna in 1873. The buildings covered 40 acres, and were occupied by 42,000 exhibitors. There were 7,254,687 admissions during 186 days, an average of 39,003 per day. The cost was $11,000,000; the receipts were $1,030,000.

1876.—The Centennial Exposition at Philadelphia, in 1876, was the sixth. The buildings covered 60 acres; there were 60,000 exhibitors and 9,910,966 admissions, a daily average of 62,323. The cost is stated at $8,500,000; the receipts are said to have been $3,800,000.

1878.—The seventh exposition was in Paris in 1878. The buildings covered 60 acres and the exhibitors numbered 32,000. There were 13,000,000 admissions during 194 days, a daily average of 67,010. The official report makes no mention of cost or expenses, though it is believed the enterprise did not pay.

1889.—The eighth was at Paris in 1889. The buildings covered 75 acres and were occupied by 60,000 exhibitors. The Exposition remained open 183 days and was attended by the enormous number of 32,354,111 persons, a daily average of 181,170. The cost was $11,000,000; the receipts were $8,380,000.

1893.—The present World's Columbian Exposition at Chicago, occupies 666 acres, of which 105 acres are covered by the main buildings alone.

RECENT PRACTICE IN DRYDOCK CONSTRUCTION.

(With inset.)

While the use of wood in the construction of graving docks has been attended with very satisfactory results in this country, engineers on the other side of the water still adhere to masonry in such works. On our inset sheet this week we show plans of four masonry graving docks, drydocks as they are more commonly called in this country. These

docks were recently described in a series of papers read before the Institution of Civil Engineers; and the discussion on these papers developed much information on important features of engineering practice.

Halifax, N. S.—The graving dock at Halifax, N. S., was constructed of stone and concrete masonry on a solid rock foundation. Work was begun in August, 1886, and the dock was completed in September, 1889, at a cost not definitely determined, but estimated at about $750,000. Its main dimensions are:

	Feet.
Length on bottom, inner groove to head	500
" " top " " "	580
" " " outer " "	600
Width on top in body	102
" " floor " "	70
" of entrance at coping	89½
" of entrance at bottom	81
Depth of sill below coping	34½
" " " " H. W. S. T.	30
Height of coping above H. W. S. T.	4½

The depth, floor area and cubic capacity of this dock exceeds any other on the Atlantic seaboard, and it is exceeded in length only by the St. John's, Newfoundland, dock, and by one of the Brooklyn docks.

As the dock was founded on solid rock it was found impossible to drive piles for the cofferdams and the novel method was adopted of providing an artificial earth into which piles could be driven for a cofferdam. After dredging to the rock all over the site of the dam and for some distance on each side, and removing all loose material by divers, stiff clay was dumped from barges to a depth of 10 ft. over the area occupied by the site of the cofferdam and the piles were driven through this clay to the rock. The rows of piles were driven 6 ft. apart and the intermediate space was filled with puddle. Then as the water was pumped out, the dam was strongly stayed on the inside. The total length of the dam was 570 ft., and the greatest depth to the rock below high water was 33 ft. To facilitate construction the upper or inshore portion of this dam was divided from the other portion by a transverse dam, thus enabling work to be begun on the section of the dock in the shallower water before the deep water dam was completed. This plan worked very successfully, no mishap of any kind occurring, and the leakage being very small.

The bottom of the dock consists of a flooring of pitch pine laid on sleepers bolted to a layer of concrete. This wood floor has been found an advantage on account of the rapid drainage of the surface. The sides up to the level of the solid rock are of concrete with a minimum thickness of 3 ft., and above this point a rubble-in-cement backing with a 3-ft. concrete facing. The concrete was composed of 7 parts broken stone, gravel and sand to 1 part of Portland cement. A granite coping 1⅛×2½ ft. runs entirely around the dock and the alters have 12-in. granite caps. The dock is closed with a steel ship caisson operated by capstans and tackle and working in a caisson groove with granite quoins and bearing surfaces. Provision is also made for placing the caisson at the extreme outer entrance in the case of unusually large vessels being docked. The machinery for emptying and draining the dock consists of two vertical direct-acting high pressure engines working two centrifugal pumps 5 ft. in diameter, and one drainage engine operating a set of three throw pumps. In addition to the dock proper the work involved the construction of a wharf and jetties and the necessary railway sidings, etc. The dock was designed by Mr. J. F. La Trobe Bateman, M. Inst. C. E., and the work was carried out under his direction until his death.

Biloela Graving Dock.—The Biloela Graving Dock is located on Cockatoo Island, Sidney Harbor, New South Wales, and was designed by Mr. J. B. Mackenzie, M. Inst. C. E., under the direction of Mr. E. O. Moriarty, M. Inst. C. E., then Chief Engineer of Harbors and Rivers. Its principal dimensions are:

	Feet.
Length, outer stop quoin to head	638
" inner " " " "	608
Length of floor	580
Width between piers	88
Width at coping	108
" " entrance	84
Depth of sill below coping	37
" " " " H. W. S. T.	32
" " " " L. W. S. T.	26
" " floor " coping at head	39
" " " " sill " "	40½

The dock is built of stone and concrete masonry on solid rock and cost complete $1,339,000. The time occupied in the entire work was from February, 1883, to March, 1890.

The floor consists of a 12-in. layer of concrete consisting of 1 part Portland cement, 2 parts sand and 4.91 parts broken stone, in which are imbedded bluestone blocks 12 ins. thick, and has a longitudinal fall from end to end and a lateral fall from the center to each side. A gutter 1 ft. 6 ins. wide separates it from the lower alters, which are of concrete (1 cement, 2 sand, 5.07 broken stone) faced with 2 ins. of fine concrete consisting of 1 part cement and 2 parts of quartz gravel. Above the lower alters comes the broad alter of granite masonry, 2½ ft. thick and 4 ft. wide. The upper alters are of sandstone ashlar masonry, headers 4×2½ ft., stretchers 4½×2½ ft., with a granite coping. The entrance walls are of concrete up to 1 ft. above low water mark and above this point of sandstone ashlar 7 ft. to 8 ft. in thickness with a granite coping. The concrete wall has a batter of 1 in 24, and is 11 ft. thick at the top. The seawalls are also of concrete with a batter of 1 in 8. That on the south side is 11 ft. thick at the top and that on the north side 9 ft. The masonry of the upper part is similar to that of the entrance walls. Both are backed with hand-packed rubble, 10 ft. thick, above low-water mark.

The greater part of the concrete in the seawalls and entrance walls was deposited under water, and was composed of 1 part cement, 1.5 parts sand and 3.61 parts bluestone. Before it was deposited the bottom was prepared by dredges and divers. Then after the foundation had been prepared for a length of not less than 25 ft. of wall, a timber framing was erected over the site, the vertical posts of which were either let into sockets in the rock, or connected therewith by iron pins. To these posts horizontal walings were secured and to them the vertical planking was fastened, the inside being lined with canvas. The bottom was then thoroughly cleaned with a jet of water under high pressure, and the concrete lowered onto it in skips, containing about 1½ cu. yds., with a bottom formed of two flaps secured by a catch which could be released by pulling a rope. The materials were at first mixed dry, placed in the skips, and then lowered, but the unavoidable inrush of water, which occurred on the withdrawal of the skip, carried a large quantity of the cement to the surface, where it formed a thick scum. The concrete was therefore moistened before being lowered into position, and as it was found that in this way less scum was formed, the system was subsequently adhered to. The concrete was deposited in lengths of between 25 ft. and 50 ft., each connected with its neighbor by a joggle.

The inverts and invert walls are formed of sandstone ashlar with granite quoins; the inner invert is 20 ft. and the outer 15 ft. broad. The caisson is of wrought iron, 90 ft. long, 14 ft. 9 ins. wide,

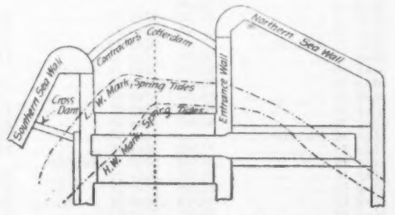


Fig. 1. Plan of Cofferdams, Biloela Graving Dock.

and 39 ft. 1½ ins. deep from deck to keel. It has a balanced falling deck and rests on delta-metal rollers 18 ins. in diameter. Flotation is obtained by means of an air space included between watertight decks, 8 ft. 10 ins. apart. Below this chamber the water has always free access to the interior of the caisson, and above it, also, when the caisson is in place. When the caisson has to be floated for moving it in or out of place the water can be excluded from the interior, above the upper water-tight deck, by closing a valve. A lift of 5 ft. from the bearings can thus be obtained at high water, allowing the caisson to be swung around without fouling the masonry of the inverts.

It was at first intended to postpone the construction of the seawalls outside of the cofferdam until the work inside had been finished, but as it was found that a part of the seawalls could be used for the walls of the cofferdam and thus lessen the expense of that structure as well as enable a larger amount of excavating to be done dry, the original plans were changed and the dam built as shown in Fig. 1. The dam was built of concrete.

There are two 6×4-ft. inlet sluices to the docks, closed with balanced valves, and one outlet culvert. A pair of horizontal condensing engines with 38×48-in. cylinders coupled to a pair of double-acting 54×72-in. plungers serve to empty the dock and there is also a small engine for drainage purposes. In addition to the dock and the seawalls the work included boiler-houses, docks and other necessary appurtenances.

Alexandra Graving Dock.—Work was begun on the Alexandra graving dock, at Belfast, Ireland, in April, 1885, and the entire work, comprising, besides the dock proper, two timber jetty quays, engines, pumps, buildings and a 100-ton derrick crane, was finished in May, 1889. The designs were made

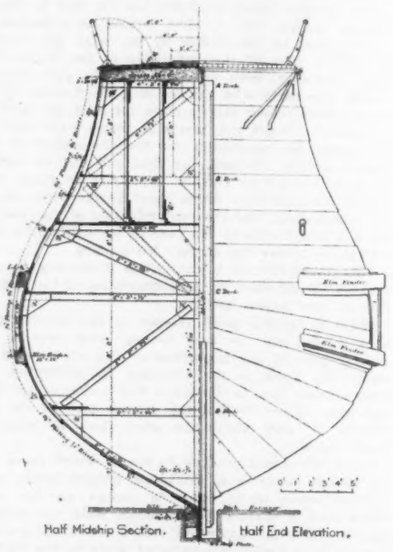


Fig. 2. Ship Caisson for the Alexandra Graving Dock.

by Mr. Thos. R. Salmond, M. Inst. C. E., Engineer in Chief to the Belfast Harbor Commissioners. The principal dimensions of the dock are:

	Feet.
Length along floor to center of outer caisson groove	800
" outer sill to back of wall	850
Width back to back of side walls	98
" inside of walls at top	92
" " " " " bottom	50
Depth, coping to floor	31
" of sill below low water	17
" " " " high water	25
Width of entrance at coping	80

The dock is divided into three sections, the outer of which is 300 ft. long, the middle 200 ft., and the inner 300 ft., and between each is an entrance sill with caisson groove, so that with three caissons the dock can be divided into three separate docks or used as one large dock. Longitudinally the floor is level on the center line, but it falls 6 ins. from the center line to each side where 12×12-in. culverts convey the drainage water to the pump wells. The dock floor and sills are at the same level, so that the keel blocks may be set on both to suit any length of vessel up to 800 ft. The side walls and floor, and the return walls of the entrance basin, and the upper part of the west quay walls, were constructed of concrete in situ; the hearting concrete being 1 part Portland cement, 2 parts sand, 1½ parts gravel and 1½ parts whinstone, and the facing concrete being 1 part Portland cement, 3 parts fine gravel and 1 part sand. The coping stones, caisson groove stones, side quoins, invert sills and entrance side walls up to low-water mark are of granite. The face work, to a depth of 9 ins., of the alters and stairs of the dock, the side walls of the entrances, the return walls at the outer entrance and the west quay wall of the entrance basin, are concrete, set in molds and smoothly finished. The inlet and outlet culverts are of concrete and brick masonry, the side walls being concrete and the arched crown and invert of brick, and are closed with wedge-shaped, double-faced gates, operated by vertical screws.

Two ship caissons, which will fit any one of the three caisson grooves, have been provided for closing the dock. The general design of one of these caissons is shown in Fig. 2. The hull is of wrought iron framed and braced together, and there are four decks. The frames of the hull and the deck-beams are angles and the plating varies from ⅜ in. in thickness for the upper part, to ⅝ in., for the lower part. The large plates are laid with their greatest lengths horizontal, in alternate inside and outside strakes, with vertical butt joints. Between the two upper decks (A and B) in the center of the caisson is a room with water-tight floor and bulkheads in which the engine, boiler and pumping machinery are placed. The upper deck is floored and carries a roadway.

A large portion of the site on which the dock was built consisted of land reclaimed from the sea by depositing the material raised by dredging and the dock walls and floor were founded in this material at a depth of from 39 ft. to 41 ft. below the present coping level. A cofferdam was constructed across the foreshore opposite the entrance and the excavation carried on dry. The excavations were made by sinking trenches on the site of the walls and concrete deposited, before excavating the body of the material. The timbering for these trenches consisted of 12×12-in. walings placed 4 ft. apart and held by 12×12-in. timber struts placed 8 ft. apart. Behind the walings 4 ft.×1 ft. ×1 to 2-in. poling-boards were placed close together. The average width of the trench was 22 ft. This timbering caused some trouble. In several instances the poling-boards gave way or became displaced. There was considerable difficulty in placing the lower layers of concrete owing to springs, necessitating the construction of distributing channels.

The machinery for emptying the dock consists of two 500-HP. horizontal compound non-condensing engines coupled to pumps capable of discharging 10,000,000 gallons in 2½ hours. The leakage is provided for by one horizontal, non-condensing, oscillating engine driving a centrifugal pump 9 ins. in diameter. The two jetty quays, 510 ft. and 840 ft. long, were timber trestle-work. The foundations for the quay walls and for the 100-ton derrick were of concrete. The total cost of the work was $745,000.

Shortly after the completion of the work fine cracks began to appear in the concrete side walls and bottom of the dock. These gradually increased in size, and water, highly charged with saline matter, began to exude from them. The concrete began to disintegrate, and some of the fissures enlarged so much as to permit the passage of fine sand from the back of the wall. An investigation was made by Messrs. Hayter & Hawkshaw, engineers, who reported that the disintegration was due to the presence of magnesia in large quantities in the work. The presence of this substance was due to the seawater which percolated the walls from the back, owing to the hydrostatic pressure, and abstracted the lime from the cement by the formation of a magnesian hydrate. The remedy suggested, and which has thus far proved satisfactory, was to cut away the defective material and to replace it by the best possible Portland cement concrete, and thus by rendering the work as impervious as possible, prevent the constant influx of the seawater which carried with it the destroying element.

Concrete Graving Dock, Newport.—In the character of the foundation site the concrete graving dock, at Newport, Monmouthshire, resembles the Alexandra grading dock. It is built of concrete throughout, with the exception of the hollow quoins and sills which were granite, and its principal dimensions are:

	Feet.
Length from head to miter of gates	350
Breadth on floor	50
Depth from coping to sill level	30½
" " " floor	33½
Width at top	72
Depth of water on sill H. W. S. T.	21⅝
" " " " H. W. N. T.	13⅝

Work was begun in January, 1889, and completed September, 1890, at a cost of $125,000. Mr. Robert Pickwell, Assoc. M. Inst. C. E., was the designing engineer.

As will be seen from the illustration, the space available for the dock was limited and a portion of the land had to be reclaimed from the water. A strong timber breastwork was constructed from U to V and from V to Z a cofferdam was constructed. The side walls were then constructed in trenches excavated 16 ft. wide. The concrete consisted of about 8 parts of broken steel slag and sand to 1 part of cement, and was laid in molds in 12-in. to 18-in. layers, the skin and heart concrete being kept separate in depositing, but afterward thoroughly worked together. To give additional strength to the dock floor against both upward and downward pressure, second-hand ships' cables were laid across the walls 7 ft. apart, and subsequently, when the floor was put in, similar cables were stretched across and fastened to the short lengths in the side walls. Similar cables were used in the abutment walls of the lock, running from the outer end of the abutment walls to a point about 80 ft. along the inner dock walls. These cables were placed in pairs at about every 5 ft. in height of the walls. It was also found necessary to drive pile foundations for portions of these walls.

In building the floor the earth inside the trenches was removed to a depth of about 20 ft., this leaving sufficient resistance at the base of the wall to prevent sliding. Beginning at the head of the dock the earth remaining was removed in sections running across the dock and 15 ft. wide, the concrete floor being completed for each section before the excavation of the next was begun. In putting in the concrete the bases of the side walls were cut away in the form of an inverted skewback so as to afford a more secure joint for the floor. When half the thickness was in the chain cables were stretched across from wall to wall and shackled to the short lengths in the walls. These cables were generally about 1¼ ins. in diameter and weighed about 85 lbs. per fathom. Considerable trouble was had in putting in the floor of the lock pit, owing to a spring or "blow" of water, but by using sheet piling and increasing the material it was made secure.

To test the force of the hydrostatic pressure on the underside of the floor a broken stone drain connection was made to a 9-in. vertical pipe passing through the floor. It was found that the water would just flow over the top of the pipe when it was 9 ft. above the floor. This standpipe was afterward removed and a cover was bolted on. In case of need a pump suction pipe can at any time be inserted here to relieve the dock floor of hydrostatic pressure. The engineer calculated the resistance of the dock floor as a beam resting on supports 48 ft. apart, ignoring the added tensile strength due to the imbedded cable. Taking four tons as the coefficient of strength, he found that the theoretical calculations were not borne out by experience in this case, because, according to the formulas, this section of the dock bottom as a beam would only support itself at about 10 ft. span; whereas the weaker parts of the dock floor, which were only 5 ft. thick, had resisted a head of water of 9 ft. over that necessary to counterbalance the dead load. In other words, theoretically, the floor ought to have been forced up long ago, but it had not.

The principle of regarding the floor as a beam in resisting the upward pressure was discussed at length, by Sir Benj. Baker, M. Inst. C. E., and he considered it erroneous. The upward pressure of the water on the floor was accompanied by a lateral water pressure at the back of the walls, which put a compressive stress in the floor, and formed what might be called a concealed arch in the thickness of the floor.

It will be noticed that instead of caissons, as in the three docks previously described, gates were used to close the Newport dock. The keel and miter posts of the gates consisted of one piece of English oak 20×20 ins. and the other framing was of pitch pine.

Comparisons of Cost.—As a rule, graving docks are not in themselves paying enterprises, and it consequently behooves engineers to exercise strict economy in their design and construction. Estimating the cost of the Halifax dock at $750,000, and taking the costs of the other three as given, $1,600,000, $735,000 and $125,000, respectively, the cost per cu. ft. of the Halifax dock was $10, of the Biloela dock, $17.50, of the Alexandra dock, $8.25 and of the Newport dock, $5.75. The great costs of both the Biloela and Halifax docks were probably due in a large measure to the extra cost of labor. The rock excavation necessary at both places also increased expenses and in addition the designs for the Biloela dock called for some very costly details, as, for example, the use of delta metal for the caisson bearings, bringing the cost of the caisson alone up to $85,000.

At this point the comparative advantages of caissons and gates suggested some points of interest. As before stated, the cost of the caisson for the Biloela dock was $85,000, and the cost of the two caissons for the Alexandra dock was $43,800, while the cost of the gates for the Newport dock was but $7,250. Laying aside all other questions than cost these figures seem to show a large balance in favor of gates, but a study of other works indicates that this balance is excessive. For example, the gates for the dock at Southampton, England, built with an 80-ft. entrance, in 1833, cost $25,000, while one of the caissons for the Alexandra dock cost $21,900 and one for the Barry dock cost $19,000. Aside from cost, caissons possess some advantages over gates. A single caisson can be made to suit several entrances; its top can be used as a roadway, and it can be easily docked for repairs, all of which advantages are lost with gates.

Returning to the question of cost it would be interesting to know just how the costs of these docks compare with docks of equal size constructed of wood as is usual in America. Unfortunately, no detailed figures are available. Remembering that the cost of labor is much greater here than in England, however, some rough comparisons are possible. The contract price for the timber dock at Brooklyn, N. Y., 500 ft. long, 130 ft. wide at the top and 50 ft. wide at the bottom, was $548,700, or about $1,100 per lin. ft., and $975 per lin. ft. for any length over 500 ft. Reducing the costs of the four docks described to the same terms we have costs of $1,250, $2,200, $655 and $350, respectively.

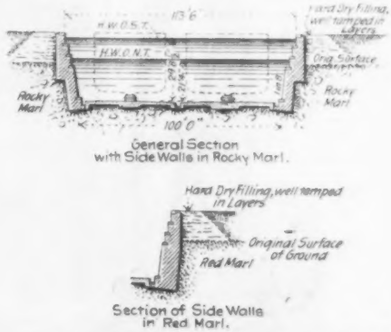

H.W.O.S.T.
H.W.O.N.T.
Hand Dry Filling, well tamped in Layers
Orig. Surface of Ground
Rocky Marl
100'0"
General Section with Side Walls in Rocky Marl.
Hand Dry Filling, well tamped in Layers
Original Surface of Ground
Red Marl
Section of Side Walls in Red Marl.

Fig. 3. Cross Section of the Barry Graving Dock.

The price of labor in Australia and America is about the same, which admits of a comparison between the Brooklyn and Biloela docks. This shows a difference of nearly 50% in cost per lin. ft. As before stated, however, the cost of the Biloela dock seems to have been excessive in certain details. A much more reliable comparison is afforded in the wooden dock at St. Johns, Newfoundland. This dock does not vary much in size from the Halifax dock, and the cost of labor is practically the same at the two places. The cost of the St. Johns dock (Eng. News, Oct. 12, 1889) was about $1,000 per lin. ft., as compared with $1,265 per lin. ft. for the Halifax dock.

Sub-Drains for Dock Floors.—Rendering the walls and floor impermeable to water is usually considered a prime requisite in graving dock construction, and where the hydrostatic pressure is large, this requires the masonry to be quite heavy, besides entailing other dangers as is instanced by the failure of the concrete in the Alexandra dock before-mentioned. The question thus arises whether it is not better to allow free access into the dock of this water and to remove it as fast as it enters by suitable pumps. This plan has been adopted in the construction of the Barry dock, and has worked very successfully. This dock is 740 ft. long, 100 ft. wide on the floor and 113 ft. 8 ins. wide at the top and provides for four ships placed in pairs side by side, as shown in the illustration, Fig. 3. Owing to the width of the floor, it was evident that the cost of one impervious to water would make it out of the question, and the engineer, Mr. J. Wolfe Barry, M. Inst. C. E., decided to introduce drain pipes into the walls and floor and give free entrance to the water. In the Halifax dock the method was

adopted of draining the floor underneath into a well from which the water could be pumped.

Action of Sea Water on Concrete.—With regard to the question of the failure of the concrete at the Alexandra dock, it is important to note that this occurred only where the walls were subjected to the unbalanced pressure of the tidal water. As is well known, concrete deposited in water which has access to all sides, does not easily disintegrate un-

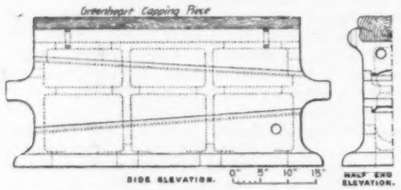


Fig. 4. Cast Iron Keel Block, Alexandra Graving Dock.

less defective in some way. In this case the water was forced into the pores of the concrete, and being free to percolate through, was constantly renewed, thus making the precipitation of the magnesian hydrate continuous. Analysis of the disintegrated material at the Alexandra dock is stated to have fully confirmed the opinion that the formation of magnesian hydrate was the cause of the failure. At the same time some question was raised in the discussion of this matter as to the correctness of this theory, several being disposed to think that the disintegration was due to imperfect methods of making or depositing the concrete.

Keel Blocks.—In the use of cast iron or wood for keel blocks the evidence seems to be in favor of cast iron. It was stated that cast iron blocks of the form shown in Fig. 4 had been used at Belfast for 25 years, and were regarded as preferable to wood, and considering their great durability fully as cheap.

Relative Merits of Pontoon Docks and Fixed Docks.—The following is abstracted from the remarks made in the discussion on these papers by Sir Frederick Bramwell:

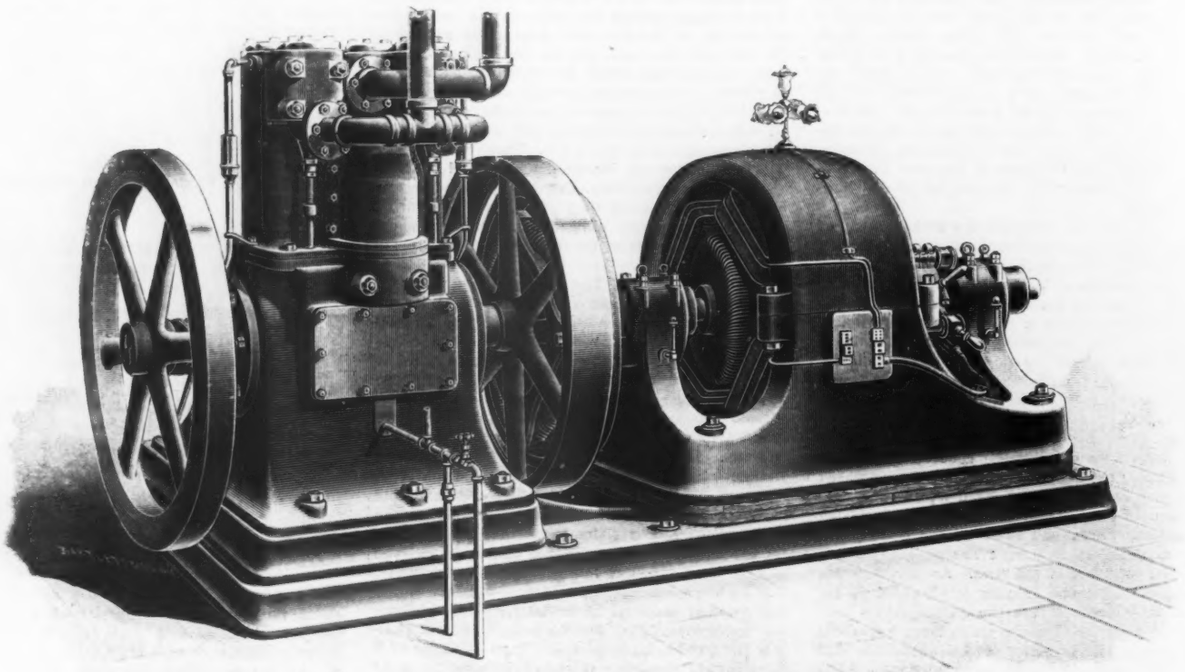
In a properly constructed pontoon dock the amount of water to be pumped out in docking any particular vessel is extremely small. Instead of the large pumping engines used with fixed docks a pair of 12-in. pumps on each side of the dock is ample, and a vessel of 2,000 or 3,000 tons can be readily docked in three hours. If the sides of the docks are made with an open framework, with suitable floats in the framework to preserve the equilibrium of the dock, such docks are very useful indeed in tropical climates, because they float on the surface of the water, and there is a free draft of air right through them. As a mere matter of comfort to the men at work and of rapidity of drying the paint put upon the ship's bottom, they are superior to docks with closed sides. Moreover, if it is desired to take in a ship of shallow draft, it is only necessary to lower the dock to the exact point required and raise it again. The water to be pumped is about in proportion to the amount of work to be done; whereas, in the case of a deep fixed dock taking in a shallow ship, it is necessary to pump the dock out to the bottom. On the other hand, where there is a very large trade and where there is a good foundation to begin with, it may be that the solid dock is better. Surely, however, the floating dock is well worthy of the attention of any engineer who has before him the problem: "Of what nature shall I make the graving docks I have to provide for the port about which I am advising?" At the present price of steel a floating dock will probably compare favorably with the fixed dock in price and will certainly do so if the foundations are bad.

A pontoon dock designed in 1867 has been working successfully for the past 20 years.

Securing a Smooth Face on Concrete Walls.—The specifications for the Newport dock required the contractor to wash his molds for the culverts, quoins, etc., with a solution of brown soap of the consistency of paint to prevent the concrete from sticking to the mold. It was found, however, that the men in using their shovels between the molds and the concrete worked the soap into the later with the effect of destroying its setting properties.

Petroleum was then substituted for the soap with excellent results, and good results were also obtained by simply having the molds well cleaned.

In closing it may be stated that the opinion was quite extensively expressed that the tendency in constructing graving docks was not to consider the probable increase in the size of vessels in the near future as fully as should be done, and that in a few years none of the docks now being constructed would be able to accommodate any but the smaller vessels.



PITTSBURG GAS ENGINE DRIVING ELECTRIC GENERATOR.

THE PITTSBURG GAS ENGINE.

Internal combustion engines, in which the combustion of fuel takes place in the working cylinder, are being extensively adopted for independent plants, and the gas engine is gaining in favor for this class of service. The principles of the internal combustion engine have been presented in our issues of March 19 and May 2, and we illustrate this week a new type of gas engine, know as the Pittsburg gas engine. It is the invention of Mr. Albert Schmid, of Pittsburg, Pa., and the details of governor and valve gear have been worked out by Mr. Bechfeld. The illustration represents a 100-HP. engine coupled direct to an electric generator.

The engine is vertical, in order to insure economy in space, and a chamber incloses the main bearings and lower end of the cylinders. This chamber is filled almost up to the shaft with a mixture of oil and water, into which the crank shaft and connecting rods splash at every revolution, so as to completely deluge the bearings, piston and interior of the cylinders, thus affording copious self-lubrication and supplying a jacket to the piston. Oil for the crank chamber is introduced through the main bearings, which are supplied from the only two oil-cups on the entire engine. A simple pipe connection with a city main supplies the necessary water. Another pipe, serving to carry off the overflow, is made, by means of a funnel head, to indicate the level of the lubricants in the crank chamber.

The engines are built with two cylinders on a single shaft, and abnormal heating is obviated by the employment of water jackets. Each revolution made by the engine operates valves admitting the gaseous fuel alternately to the one or the other cylinder. As the period of admission is controlled by a positive action, the crank shaft receives an impulse once each revolution, no matter what the load, but the energy of that impulse is predetermined by an independent piston valve, which valve is so designed that it shall always admit gas and air in the right proportion for producing their correct maximum result, but at the same time vary the total amount of mixture directly as the work of the individual piston stroke. By reason of this adjustment of the energy developed to momentary load, and by the unvaried use of fuel at its maximum efficiency, the engine is claimed to develop a much greater amount of work per given unit of gas, than any other generator thus far brought out. Furthermore, as the shaft receives once every revolution an impulse that is proportioned to its load the speed is maintained smoothly and regularly.

Another special feature is the patent automatic governor, which both regulates the speed and controls the admission of fuel to the cylinder. It is mounted upon the shaft, between the cranks, and, by direct connection between the eccentric rod and valve stem, insures an accurate and positive travel to the measuring slide valve. This governor has been used on steam engines, but this is the first application to the gas engine. The patent sparker for igniting the fuel charge consists of an arm

operated by a cam, which arm is made to break an electric circuit, and the arc thus formed, intensified by the use of an induction coil, ignites the fuel instantly. As the arm is actuated by a positive motion, there is no failure to produce a spark and no failure in the resulting ignition of the fuel. In order that the engine may be entirely self-contained, the electric current is supplied from a galvanic cell. If preferred, however, the requisite energy may be taken from a dynamo circuit.

The engine is equipped with a moderately heavy flywheel, a bandwheel, where belting is to be used, the necessary gas bag, and other fittings. All stop-cocks and faucets are conveniently arranged on one side, and the oilcups are supplied with a sight feed and so placed as to be easily got at and regulated. Both at front and at back the crank chamber has large openings through which the shaft, governor rods, etc., may be reached by the loosening of a bonnet. The interior of the cylinders is similarly easy of access. The head is made removable, thus allowing ingress for an occasional cleaning out of the dirt resulting from gas combustion.

An engine rated at 9 HP. on the brake, with cylinders 6×11 ins., has been tested, using city illuminating gas as a fuel, which is more expensive than common fuel gas. The gas meter employed was a standard one, manufactured by the Fuel Gas & Mfg. Co., of Pittsburg, and guaranteed correct within 1%. The springs for indicator work were carefully tested, and the results corrected for any small error. The indicators were placed directly upon the cylinder cases. For measuring the delivered horse power, a Prony brake was used, having a wheel 27⅝ ins. diameter, and an arm 29 1-16 ins. long. The indicated horse power was calculated in the usual way, from the number of revolutions and effective pressure. The duration of each of the three runs made, A, B, and C, was two hours.

		A.	B.	C.
Load		Full	¾	0
Load on brake in lbs.		75.8	52.6	0
Revolutions per minute		223.5	223	221
Pressure in lbs. per sq. in. in cylinders:				
Mean initial	Cylinder I	159	103	27.4
	" II	161	191	28
Mean terminal	" I	25	18.8	8.8
	" II	25.3	19	9
Mean effective	" I	61	47	17
	" II	61.5	47.2	17.0
Indicated H. P.:				
Cylinder I		5.38	3.50	.80
" II		5.40	3.62	.82
Totals		10.78	7.21	1.62
Brake horse power		9.10	5.80	
Horse power loss in friction		1 68	1.41	
Mechanical efficiency		84%	80%	
Gas:				
Temperature, degs. C		22	16	15
Pressure in inches		1.5	2	2
Amt. in cu ft., at 0°.C. consumed per hour		165	121.8	50
Amt. in cu. ft., at 0°.C. consumed per hour per i H. P		15.3	10.9	30.8
Amt. in cu. ft. at 0° C. consumed per hour per B. H. P		13.2	21	
Water Jacket:				
Lbs. of water used per hour		1,538	1,210	1,009
Rise in temperature, degs. C		220.2	19	17.8

With the conditions of the test as given, the energy received and expended per hour was divided as follows:

Total energy received, ft.-lbs.	55,200,000	40,800,000	16,750,000
Total energy expended:			
indicated work in ft.-lbs.	27,280,000	14,330,000	3,200,000
water jacket ft.-lbs.	21,900,000	17,800,000	1,382,000
exhaust radiation, etc., in ft.-lbs.	10,020,000	3,740,000	12,168,000
Efficiency for 1 HP.	39%	33%	19%
" " B "	33%	28%	

The engines are manufactured by the Fuel Gas & Mfg. Co., of Pittsburg, Pa., and are made in sizes of ¼ HP. to 200 HP.

PERSONALS.

Mr. C. S. Gamble has been elected City Surveyor of Muskegon, Mich.

Mr. S. D. Baltimore has been appointed Assistant City Engineer of Troy, N. Y.

Mr. John D. Crimmins has resigned his position as President of the Metropolitan Traction Co., of New York.

Mr. James F. Parr, Pineville, Ky., has been appointed Chief Engineer of the West Virginia, Pittsburg & Tennessee R. R.

Mr. Kerr, General Superintendent of the Consolidated Mining Co., Roanoke, Va., has resigned, and will enter business as an engineer.

Mr. Thomas D. Robinson has been appointed Surveyor-General of Colorado. He was at one time City Engineer of South Denver, Colo.

Mr. Bernhard Feind, M. Am. Soc. C. E., until recently Consulting Engineer to the city of Chicago, has removed his office to the Rookery Building, Chicago, for the practice of general hydraulic engineering

Mr. James Parks, one of the originators in 1848 of the Steubenville & Indiana R. R., which was the first part of what is now the Pittsburg, Cincinnati & St. Louis R. R., died at Steubenville, O., June 19, at the age of 87.

Mr. Thomas T. Johnston has been appointed First Assistant Chief Engineer to the Chicago Sanitary District Commissioners; Mr. U. W. Weston, Superintendent of Construction, and Mr. D. C. Dunlap, Assistant Superintendent of Construction.

Mr. Henry R. Long, of San Diego, Cal., has been appointed Chief Engineer of the Los Angeles, Owens Valley & Utah Railway, and in a few days will begin the survey. The company's plan is to build the gap of 153 miles between Mojave and Independence.

Mr. John Fritz, of the Bethlehem Iron Co., has been awarded the Bessemer medal by the Iron and Steel Institute, of Great Britain, as already noted, and the Council of the American Society of Mechanical Engineers has adopted the following resolution respecting the award:

The Council desires to commend the excellent judgment of the Iron and Steel Institute in selecting for this honor one who, by his genius, skill and industry through many years, has done so much toward the improved metallurgical processes, and especially in the construction of the mechanical appliances now in use in the manufacture of iron and steel in this country, as to have materially aided in making this industry the important one it now is. In conferring the "Bessemer Medal" in this year of our "Columbian Exposition" upon an American engineer, the Institute has in a pleasant way added further evidence of the kindly feelings and hearty goodfellowship which in so many ways has of late marked the action of engineering societies and engineers in this country and in Europe. We cannot but believe that courtesies like this tend to a closer union of engineers in all lands, and that while it is the mission of our profession to compel the rude forces and materials of nature to contribute to the welfare and comfort of mankind, it is their mission as well to bring in closer touch nations and individuals, and in this way aid in a degree it would seem, as no other profession can, to bring about those better days which in all ages past the world has hoped and struggled for.

Mr. Leland Stanford, United States Senator and Chairman of the Executive Committee of the Southern Pacific Co., died at Palo Alto, Cal., June 20. He was born in Watervliet, N. Y., in 1824. He studied law, and in 1849 was admitted to the bar. In 1852 he went to California, where he soon became interested in gold mining with his three brothers. He left them in 1856 and settled in San Francisco, where he established a mercantile business, retiring with a large fortune. When the Central Pacific R. R. Co. was organized in 1861 he was chosen president, and superintended the construction of this road, and drove the last spike at Promontory Point, Utah, on May 10, 1869. Later on he became interested in other roads on the Pacific slope. He was governor of California in 1862 and 1863. He was president of the Southern Pacific Co. from 1884 to 1890, and on Mr. C. P. Huntington's election to that office he became Chairman of the Executive Committee. He was known principally for his early and prominent connection with the Central Pacific R. R., which, with its connection, the Union Pacific R. R., formed the first transcontinental railway. The Union Pacific R. R. was built from Omaha to Ogden, and the Central Pacific R. R. was to reach from Ogden to San Francisco. The natural difficulties were great, and the work had to be done quickly. Part of the route lay through level plains, and here it was pushed as railway building had never been pushed before. Ten miles of track were laid in a single day and 530 miles in 263 days. The rest of the road lay among the wild crags and deep ravines of the Sierra Nevada, and here the cost of construction was colossal, over $20,000,000 being spent on 100 miles of the line. It was largely through Mr. Stanford's energy that the work was successfully carried out, and on May 10, 1869, the work was done, the last spike being driven by his own hand. The silver hammer which he used on that occasion had a telegraph wire attached to its handle, and at the stroke the news was flashed that the transcontinental railway was completed. Mr. Stanford's property is valued at about $50,000,000.

NEW PUBLICATIONS.

ABSTRACT OF DECISIONS OF THE ARBITRATION COMMITTEE OF THE MASTER CAR BUILDERS' ASSOCIATION. Compiled by J. D. McAlpine, New York: "Railroad Car Journal." 16mo; pp. 48.

This pamphlet gives abstracts of the committee's decisions in cases 1 to 186, from November, 1888, to May, 1893. It contains also a table of words often mispelled in defect cars or car reports, and a table of synonyms of parts of cars known by different names.

WOODEN AND METAL TIES.—Standard Steel Railway Tie Co., New York. Two pamphlets. 12mo.; pp. 16 and 24.

These two pamphlets contain extracts from various papers on the subject of steel ties and on the consumption of wood for railway ties, with reference to the substitution of metal. Some particulars are given of the Standard steel ties (Eng. News, Feb. 7, 1891) on the Chicago & Western Indiana R. R. and other railways.

THE OFFICIAL RAILWAY LIST: A complete Directory of the presidents, Vice-presidents, General Managers and Superintendents, Chief and Assistant Engineers, Secretaries, Treasurers, etc., etc., of Railways in North America, and Handbook of Complete Information for Railway Men. Waldo H. Marshall, Editor. Chicago, 1893: Railway Purchasing Agent Co. Cloth, oblong, 4½ × 8½ ins.; pp., 477; price, cloth $2, flexible leather $3.

The contents of this little volume are clearly indicated in the title, and differ very little from those of former issues which are already familiar to many of our readers. The book is intended primarily for railway supply men, and others requiring a compact and handy directory of railway officials.

PROCEEDINGS OF THE 21ST AND 22D MEETINGS OF THE AMERICAN SOCIETY OF RAILROAD SUPERINTENDENTS. Secy., C. A. Hammond, Boston. Separate pamphlets. 8vo; pp. 130 and 96; both illustrated.

The report of the proceedings of the 21st meeting, held in New York, October, 1893, includes papers on "The Evolution of the Railway Tie Plate," "A Method of Drawbridge Protection" and "Notes on the Block System," together with the reports of the committees on Machinery relating to compound locomotives and the Morton car-heating system, on Signaling, and on Transportation. The latter report referred to a proposed printed catechism for the examination of conductors, enginemen and trainmen as to train rules and train orders, and it gave rise to considerable discussion, which is reported in full. There is an appendix giving the experience of roads using the standard code of train and telegraph rules. The report of the proceedings of the 22d meeting, held in Chicago, April, 1893, has a paper by Mr. C. H. Platt, on "Block Signals," with considerable discussion, and has a description of the Lattig automatic electric block semaphore (already described in our columns) as an appendix.

MICHIGAN STATE BOARD OF HEALTH: Report for 1890. Henry B. Baker, Secretary. 8vo, pp. 331; many tables.

This report contains some very careful studies of vital statistics and zymotic diseases.

HYDROGRAPHY OF THE OIL REGIONS: Extract from the Twelfth Annual Report of the Director of the United States Geological Survey. By F. H. Newell. 4to, pp. 361; 49 plates, 7 figures and many tables.

The first few pages of this volume are occupied with some general observations relating to the subject, and the balance of the book is taken up with facts and figures regarding the hydrography of the Upper Missouri and Yellowstone, Platte, Arkansas, Rio Grande, Colorado River, Sacramento and San Joaquin and the great drainage basins and the drainage of the Snake River. Tables and diagrams relating to the discharge and stages of the various rivers given and some fine half-tone views are presented.

TRADE PUBLICATIONS.

B. & O. RAILWAY GUIDE.—Baltimore & Ohio R. R., Baltimore, Md. 8vo; pp. 92; illustrated.

This is a profusely illustrated tourist book, compiled by H. H. Phillips, relating to the World's Columbian Exposition and the trip thereto over the Baltimore & Ohio R. R. The preparations made by this road for ots Exposition traffic were noted in our issue of June 8.

SOCIETY PROCEEDINGS.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—(Concluded from page 507).—The last session was opened on Wednesday morning, June 21, with the report of the Committee on Boiler Attachments. The replies to the circular letter issued by the committee may be summarized as follows:

1. Give a list of the parts attached to your standard locomotive boiler, which, if broken off in case of accident, would leave opening in boiler. A. Average number of openings reported, 11.

2. How could the number of openings in boiler for such attachments be diminished? A. "By use of steam chamber," 13; two favored use of water column instead of gage cocks; one favored both injectors on one side, and one recommended abolishing some of the attachments.

3. In what way could such openings be protected to prevent the escape of hot water or steam in case attachments are accidentally broken? A. "Inside valves," 6; "Automatic valves," 7; "Heavier attachments," 1.

4. What is the best method of connecting check valves to boilers—flange joint, or screwed direct into boiler? Give size of connection that should be used. Have you had any experience with inside check valves, and what is your opinion of their safety and efficiency, compared with outside checks? A. "Favorable experience with inside checks," 3; "Unfavorable," 2; "Experimenting," 5.

5. Do you think it necessary or advisable to use water glasses in addition to gage? What size do you use? Is it advisable to use an automatic valve in water-glass cocks to prevent the blowing of steam and hot water in case of water glass breaking? A. "Water glass necessary," 14; "Unnecessary," 9; "Automatic valves necessary to protect gage cocks," 7; "Unnecessary," 5; "Prefer shield," 2.

6. Is it your practice to use a steam chamber to connect blower, injector valves, steam heating valves, etc., or is it your practice to connect these attachments separately to boiler? Is there any provision made to close the connection between steam chamber and boiler? A. "Steam chamber used," 18; "Not used," 5; "No provision to close connection," 8; "Ordinary valves," 4; "Automatic valves," 5.

The committee's recommendations were as follows:

1. That all connections for conveying steam from boiler, excepting gage cocks, water gage glasses, check valves, blow-off cocks, service cocks, whistle and safety valves, be attached to the steam chamber, connected to boiler by flange, to be bolted to the top of boiler or to the back side of dome, and that a self-closing or automatic valve be used inside of boiler or below a point where the connections with the boiler are liable to be broken and a valve be placed between chamber and boiler.

2. That a gage cock with guard valve inside of boiler is quite desirable; but the committee, not knowing of any form of such cocks which is entirely satisfactory, refrain from recommending any.

3. That water-gage glasses are not a necessity, while they may be a convenience to engineers and firemen and that when they are used they should be supplied with automatic closing valves.

4. That the check valves be attached by flanges to the back boiler head, and the feedwater be conducted to the front end of boiler by a pipe or trough inside of the boiler, or when the connection of check valves to boiler cannot consistently be made to the back boiler head that a double check valve might be attached to back side of dome and the water conveyed from this to the front end of the boiler by a pipe or open trough, and that only one opening be made in boiler for connecting the check valves, this opening to be protected by a guard valve inside, and a double T-pipe with two check valves, one for each injector, be provided outside.

5. That blow-off cocks be placed in the front or back ends of fireboxes and not on either side.

6. That all studs screwed into boiler be made with a weakening groove outside.

7. That the whistle valves be placed inside of the boiler, and, if not, that a separate guard valve be provided.

8. That safety valves be placed in a recess in dome cover below the top of dome, so as to be protected from injury in case of collision or other accident.

The discussion on this report was confined chiefly to the question whether the water glass was a necessity or not. Representatives of Eastern roads which have good water that gives little trouble from foaming and incrustation were strongly of the opinion that the water glass was not a necessity, and many were in doubt as to whether it gave any greater safety to use it than to leave it off. Theoretically the engineer has two appliances instead of one by which to determine the height of the water in the boiler; but practically he is apt to habitually use only one and leave the other to get stopped up and useless. Besides this there is the danger of scalding the men on the locomotive when the glasses break. The Delaware & Hudson Canal Co. has over 400 locomotives in service, and for 30 years past has never used gage cocks on them. On the other hand, the representatives of Western roads testified that the water glass was not only a convenience, but an absolute necessity on many roads using river water or alkaline water. With the boiler foaming badly the engineer cannot tell by the gage cocks alone how much water he has. On engines where the fireman is separated from the engineer it is a great convenience to have a separate glass for the fireman's use, as he can manage his fire much more intelligently. A resolution was finally adopted setting forth as the opinion of the Association that the water glass on a locomotive is to be regarded as a convenience and an additional safeguard, but not as a necessity.

An amusing feature of the discussion was the anxiety of some of the members to have the matter so disposed of that the railways would not be liable for damages in the event of a boiler exploding which was not fitted with a water glass. It was apparently forgotten that the published discussion in the annual report would at once reveal the motives for the adoption of any resolution condemning water glasses, and would thus prevent it from carrying any weight in a court. The resolution as given above, however, was a fair expression of the opinion of most of the members, except that on roads having much trouble with foaming water many think that the water glass is little short of an absolute necessity.

Concerning the place of attachment of the check valves on the feedpipe, Mr. Foster, of the Fall Brook R. R., attaches the check valve to the back boiler head and conducts the water to the front end through an open trough in the steam space. In this way the water is heated somewhat before it passes among the tubes, and the check valve is less likely to be broken off in a collision. Mr. Chas. Blackwell said that the London & Northwestern and the Canadian Pacific Ry. both followed this practice, and the late Howard Fry adopted it for the first West Shore engines.

A Standard Method of Conducting Locomotive Tests.—This report was substantially identical with that presented by the committee of the American Society of Mechanical Engineers at the San Francisco meeting a year ago (see Eng. News, May 19, 1892). The report was presented as preliminary only and the committee requested to be continued, and explained that it had been proposed to have tests made by the joint committee of the two associations on the experimental locomotive at Purdue University. The plan received hearty approval from the members, and the committee was instructed to co-operate in making such tests on the relative economy of compound and simple locomotives. The Executive Committee of the Association was directed to solicit subscriptions from the railway companies to cover the expenses of these tests.

Malleable Iron Castings.—The committee did not think that malleable iron could be recommended as a substitute for large and expensive forgings, and had found no one who was of that opinion. It could, however, be substituted to advantage in locomotive work for a great many parts now made of ordinary gray cast iron or for small and inexpensive forgings. There was no discussion.

Attachments Between Engine and Tender—Steps and Hand Rails.—This committee was appointed to investigate whether the present connection between locomotives and tenders was as safe as could be devised to prevent the tender frame from mounting or running under the foot plate of the locomotive in collisions. The replies received them indicated that the risk to enginemen from this cause is little or nothing if the chafing plates and their backing are in line and the coupling bar is horizontal and close up to the casting. The best practice is to put the coupling bar at the vertical center of the chafing plates, so that the bar must be sheared before the tender can start to mount the foot plate. The chafing plates should be of equal height on the engine and tender; should have ample backing and ample wearing surface. A stout horizontal wrought iron drawbar, with cottered coupling pins of large diameter, was recommended.

Some think the chief danger to men on the locomotive in event of collision is from the tank sliding forward on the tender frame. To prevent this the use of stout lugs riveted to the tank and bolted to the frame was recommended. The floor inside the coal space should be solidly secured to the frame, so that to shift position the tank must either mount this floor or shear it off the frame.

For safety couplings between engine and tender heavy short-link chain is generally preferred to bars. If bars are used one end must have a slotted hole to prevent binding on curves. The Duluth, South Shore & Atlantic uses for each safety chain four 6-in. links of 1½-in. iron, and connects them to the tender beam by double-ended 1½-in. staple bolts. The engine drawcasting has two pairs of pendent lugs cast on, and through these and the last link of the chain passes a 1¼-in. horizontal cottered bolt.

Chilled cast iron is generally preferred for chafing plates, although some use steel. Some make both plates flat; others make one flat and one round, and the Philadelphia & Reading curves both surfaces, with the coupling pins as centers. The use of a wedge to take up slack in the bar and wear in chafing plates appears to be common practice. The plan of curving both surfaces avoid all binding when rounding curves; but on the other hand it is said that if the curved surfaces are of short radius, the side strain, when backing around curves, tends to derail the tender or turn the rail over, and causes excessive wear on the tender axle collars. To prevent this one surface should be made flat, or else curved with a long radius. The London & Northwestern and the Pennsylvania use a spring buffer coupling arrangement on new work; and a fair inference is that the users of so elastic and flexible a connection do not consider that any risk exists to the men on the foot plate which calls for any closer connection.

For steps, the preference is usually for short steps made of iron, and protected by high flanges on three sides. The tendency is to put steps very high above the rail, probably to avoid breaking them by striking snowbanks; but the committee rather favored a step of moderate height, and dividing the vertical height from tie to foot plate into three equal parts. Wrought iron for steps can be freed from ice in winter with less danger of breakage than cast iron, and can be roughened with a diamond pointed chisel.

For handholds, long vertical handles on the tank are generally preferred. Cross hand-rails at engines on front and back were opposed by many (except on switching, suburban and way freight engines), because although convenient for the employees, they are a temptation to other people to steal rides in a dangerous place.

The discussion brought out still more prominently than the report the fact that many locomotives are very badly designed with respect to foot plate attachments and appliances for the protection of engineers and firemen. Reference was made to the locomotive exhibited at the World's Fair by the Brotherhood of Locomotive Engineers. Mr. J. Davis Barnett said he expected to find it a model as respects the appliances for the safety and convenience of the trainmen; but on mounting the foot plate he found that the brake wheel was on a level with his nose.

Mr. Henderson said that to prevent the tank moving forward on the tender frame the Norfolk & Western rivets a heavy angle iron to the rear of the tank and to the frame.

Smoke Prevention.—This report was prepared by the Chairman of the Committee, Mr. J. N. Barr, Supt. of Motive Power of the Chicago, Milwaukee & St. Paul. It stated, in substance, that the ordinary locomotive with a deep firebox and a brick arch could be fired without smoke by a careful and intelligent fireman when running. When standing still, however, some device is needed to furnish air enough to the fire to prevent the smoke, and this is the chief office of smoke-preventing devices on a locomotive. The great trouble with them is that they also force air into the fire when the engine is running and does not need more air than it gets from the draft due to the exhaust. This may cool the firebox so much as to make smoke instead of preventing it.

The Walker smoke preventer avoids this by operating automatically when both the throttle and the fire door are closed. The Barnes device has a blower in the stack and makes little noise. The roar of some steam jet devices is a great objection. As to whether the steam jet helps or hinders fuel economy, opinion is divided; but it is generally considered that smoke prevention means increased coal consumption.

Mr. A. E. Mitchell said the Erie tested the Hutchinson smoke consumer for two months, and found that more coal was burned with the device than without it. The black color of the smoke, however, was killed by the amount of steam blown in by the jet. An effective smoke-preventing device should heat the air before admitting it over the fire. The French furnace, in use years ago, did this, the air passing through a hollow brick arch in the firebox. The device was a failure on account of the short life of the arch. With poor coal especially the arch would melt down.

Mr. W. H. Marshall said that to work successfully a smoke preventer should vary the amount of air admitted above the fire according to the air openings in the grate and the thickness of the fire. Many grate bars in service have their percentage of openings greatly reduced by incrustation; it would conduce to smoke prevention to increase the area of the openings in the grate.

Mr. Pulaski Leeds said he at one time tried admitting air above the fire through two 4-in. pipes placed inside the firebox and perforated with 3-16-in. holes. The device was an excellent smoke consumer, but the pipes burned out in a very short time. At the same time an exceptionally intelligent fireman was instructed in the principles of smoke prevention, and got quite as good results in an engine not fitted with any smoke-consuming attachments.

Secretary Sinclair said America was passing through the same smoke-prevention fever which Europe had 50 years ago. There is nothing in smoke-preventing devices offered to-day which was not invented and tried many years ago abroad. Foreign railways have settled down to the brick arch, and the admission of air above the fire as the best appliances for smoke prevention, and the same will be done here. It will be found here as there that smoke prevention means increased fuel consumption.

Mr. Mackintosh pointed out that the best efforts of a careful fireman might be neutralized by a careless engineer.

Mr. Smith said the Chicago & Northwestern had about 200 engines equipped with smoke preventers, more from necessity than from choice. He had used a shield over the furnace door directing the air downward under the brick arch with a 10 in. × ¾-in. slot admitting the air, and it had worked as well as anything he had tried, except that the shield burned out and had to be replaced frequently.

Mr. McNaughton said all the Wisconsin Central engines had smoke preventers. He favored the Barnes device, as it heats the entering air and is practically noiseless. Every engineer and fireman has to fill out on his time card an answer to the question whether he has violated the smoke ordinance. These cards form a record which may be useful for the company's defence in court, and it tends to make the engine crew careful.

Washing Boilers and Testing Staybolts.—An interesting discussion took place at the noon hour on this topic. There is a great diversity of practice as to washing boilers. Practice on the Nickel Plate is to blow off the water from the boiler and let it stand full of steam for an hour to cool down gradually. It is claimed for this practice that it softens and loosens the scale, and against it that the scum on the surface of the water collects on the shell of the boiler as the water level falls and is baked on by the heat. A better practice on the whole appears to be to fill the

boiler full of water as soon as the engine comes in, and keep lowering the temperature as the water circulates out and in until it is cool enough to be washed out. When the boiler is once cooled it makes little difference whether hot or cold water is used for washing. Most of the boiler washers which pretend to use hot water do not really do so, as they can't get steam enough to heat the water.

Concerning inspection for broken staybolts, Mr. Mackenzie has this work done after the water has been blown from the boiler, but while it is still filled with steam. The sound of a broken bolt is heard more readily with no water between the broken ends. Others test while under steam, believing that the pressure will tend to separate the ends of broken bolts and make their detection surer. Others objected to parboiling the inspectors in order to test under steam, and claimed the men would do better and more reliable work if the boiler was allowed to cool first. One member tests under cold water pressure; but the best arrangement of all appears to be that of Mr. Leeds on the Louisville & Nashville. He has two Westinghouse air pumps mounted tandem, so as to compress air to about 175 lbs. pressure, and after the boiler is cool he pumps air into it. Thus he gains the advantage of comfort to his men, and with the boiler empty and under pressure.

The discussion then turned on the reliability of staybolt inspection. Mr. Mitchell said that he recently made a test of this matter. A boiler was taken from service, and every Erie inspector was required to make a report of the number and location of broken staybolts in the boiler. Afterward the boiler was opened, and it was found that there was not an inspector who had not marked some staybolts as broken which were sound and who had not failed to mark some which were broken. The testing was done cold. Mr. W. H. Lewis said that he had a report from an inspector of five staybolts broken in a boiler, and on opening it he found 200 staybolts broken.

At this point it was suggested that nothing had been said about drilling staybolts to detect breakages. It was very forcibly brought out by Mr. T. B. Purves, Jr., of the Boston & Albany, that with drilled staybolts all the expense of inspection, water pressure, steam pressure or air pressure is saved. There is no parboiling of men in the firebox and no use for the dolly-bar or hammer. The engine house inspector merely reports any incrustation or water dripping around the ends of the stays, and once in three months the sheet metal jacket over the side sheets is taken off and a thorough inspection is made. On the Chicago, Burlington & Quincy also, all staybolts are drilled from the outside, and the inspection of staybolts in regular service has been entirely abandoned.

Tender Frames.—The report of the committee on this topic showed that metal and wood tender frames are about equally in favor. Very few of those using metal frames reported any trouble from loose rivets. Steel is almost universally used for tanks in place of iron; but two roads reported that it corroded more rapidly than iron where the coal came in contact with it. For axles, iron and steel are in about equal favor. The diamond truck seems to be in much the most general use. For truck bearings, the most common practice appears to be to use center bearings on forward truck and center and side bearings on the rear truck, though a few use only side bearings on the rear truck, and others use either side bearings or center bearings on both trucks.

The brief discussion brought out the fact that where trouble with iron tender frames had been experienced, it was due largely to their being too light.

The committee on subjects for reports at next year's convention submitted the following list: Causes of the cracking of back tube sheets; oiling fast passenger engines using high pressure steam; exhaust nozzles and steam passages; standard specifications and tests for boiler and firebox steel; sanding devices; special shop tools; a uniform system for testing boilers, especially for staybolt tests; tires, including proper shrinkage for large sizes, methods of fastening, safe limits of thickness and depth of permissible wear between turning; tests of simple and compound locomotives. After the usual routine business and the election of officers, the results of which were reported last week, a vote was passed that no presiding officer should hereafter be re-elected, and the final adjournment was taken.

THE IRON AND STEEL INSTITUTE—(From our London correspondent).—The annual meeting of the Iron and Steel Institute was held in London on May 24 and 25. There was an unusually meager list of papers, only five being announced; but to this number two more were added afterward. Both these were on the methods of determining chromium—one being by Mr. Galbraith, and the other by Mr. Stead, of Middlesborough. Neither of these latter papers, however, was read, other than by title. Another paper, by Herr Paul Kupelweiser, on "The Basic Process as Practiced at Witkowitz," was put over to the next meeting. The papers actually read were the following: "On the Elimination of Sulphur from Iron and Steel," by J. E. Stead, Middlesborough; "On the Saniter Process of Desulphurization," by E. H. Saniter, Wigan; "Notes on Puddling Iron," by John Head; "On a Recording Pyrometer," by Prof. W. C. Roberts-Austen.

On the members assembling on May 24, Sir Frederick Abel, who has been president for the last two years, occupied the chair. The usual formal business having been disposed of, the new President, Mr. E. Windsor Richards, took the chair, and, according to the usual custom, delivered an inaugural address (an abstract of which is given on another page. Mr. Richards is well known in the steel trade, having held a prominent position in that industry. He was brought up at Dowlais, South Wales, and for many years was manager of the extensive Eston Iron Works, at Middlesborough, the property of Bolckow, Vaughan & Co. A few years ago he left Middlesborough to take the management of the historic Lowmoor Iron Works, in Yorkshire, a position he still occupies. He referred to the present condition of the institute, which appears to be fairly prosperous, although it can hardly be said to have been advancing of late at the pace which its most sanguine friends would desire. Mr. J. S. Jeans, who has been secretary for the past 16 years, is to be succeeded by Mr. Brough, who is an associate of the School of Mines, and therefore a technical man.

At the conclusion of the address, the Bessemer gold medal for 1893 was awarded to Mr. John Fritz, of Bethlehem, Pa. The President, in giving a short biographical sketch of Mr. Fritz, observed that the latter was one of the small band of leaders who had so successfully developed the Bessemer process in the United States, and had astonished the metallurgical world by the enormous quantities of steel produced from comparatively small plants. Mr. Fritz had, during the past few years—in conjunction with Capt. Jaques—designed constructed and managed one of the most important armor-plate plants and gun-making works in the world, producing the highest qualities of open-hearth steel.

The next business was the reading of two papers by Mr. Stead, of Middlesborough, and Mr. Saniter, of Wigan, respectively. The subject dealt with was the desulphurization of iron—a problem which has been engaging the attention of English metallurgists for some time past. As will be remembered, Mr. Stead and Mr. Saniter both read papers at the last meeting of the Institute (Eng. News, Oct. 27, Nov. 24, 1892), and the present contributions may be looked on as continuations of those papers. Messrs. Ball and Wingham—two young metallurgists of considerable promise—have also been making experiments in this direction of late.

In the Cleveland district we have, in England, practically inexhaustible supplies of iron ore, excellent for the old ironmaking processes, but inapplicable for the manufacture of steel. The basic process has done much to make these ores available for the great metallurgical industries of the day; and if Mr. Saniter can substantiate his claim for his process as a practicable and commercial success in eliminating sulphur (as there appears to be no doubt he can), then another step will have to be taken toward rendering available the great British native ore deposits. Not only would large sums of money which now go abroad then be retained in this country, but the industry would be made independent of the chance of foreign interference and a considerable item in carriage would be saved.

Prof. Roberts Austen's paper on "The Recording Pyrometer," was next taken up, and will be printed in a later issue. Then followed Mr. J. Head's "Notes on Puddling Iron." The gist of this paper appeared to be that the silicon, carbon, etc., to be oxidized in the puddling process can be removed by the oxygen obtained from the fettling used for lining the pan or from hammer scale or other iron oxide charged with the pig.

Mr. Kupelweiser's paper, to be presented at the next meeting, describes the manufacture of steel by the combined Bessemer and open-hearth process. The rapid oxidation which takes place in the converter is well adapted to the first stages of the conversion from molten iron to steel; but the slower oxidation of the open-hearth furnace is better suited to complete the work. Notwithstanding the apparent complication of the process, it has been introduced at the Witkowitz, works, and the cost of steel production has been actually reduced $2.50 per ton compared with the cost of metal produced in the open-hearth furnace. It is understood, of course, that the basic process is referred to in the above.

ENGINEERING ASSOCIATION OF THE SOUTH.—At the meeting at Nashville, Tenn., June 8, a paper on "The Pecos Viaduct" (Eng. News, Jan. 5) was presented by Mr. J. Kreuttschnitt. In the original construction of the Galveston, Harrisburg & San Antonio R. R., of the Southern Pacific system, the deep canyon of the Pecos River presented such difficulties that, to avoid it, a considerable detour was made, and the line built with heavy grades and curvature, yet at great expense; besides, the operating expenses were large, the unstable condition of the adjacent limestone necessitating constant patrol of the track and reduction of train speed. These disadvantages led to the location of a cut-off, crossing the Pecos River on the viaduct described. The Pecos ranks one of the highest viaducts for standard gage in the world, and leads in live-load specifications and lightness. One of the most remarkable features in the work was the traveler used in erecting; it had an overhang, perhaps hitherto unequaled, 124.5 ft., which was secured by a 57-ft. wheel base, the traveler being counterbalanced and clamped to the completed parts of the structure. The iron was brought out on push cars on the permanent track, taken by the crab on the traveler, lowered and held in position till the connections were made. The heaviest pieces weighed 11 tons. After erecting the east half of the structure, the traveler was taken to pieces and shipped by the operated line to the west half, a lighter traveler meanwhile raising the short towers at the west end. In erecting the east half, 41,000 lbs. of iron was averaged per day net time, and 62,000 lbs. in the west half. The average number of men employed in erecting was 67, and 87 working days were consumed between beginning erection and connecting the suspended span. The superstructure was built by the Phoenix Bridge Co. The floor timbers are covered with galvanized iron for fire protection. Total cost of viaduct, $250,000. The paper was fully illustrated by drawings and photographs.

Walter G. Kirkpatrick, Secy.

ASSOCIATION OF ENGINEERS OF VIRGINIA.—The summer meeting will be held at the Hotel Rockledge, Mill Mountain, Roanoke, Va., on June 30 and July 1. The following papers will be read and discussed: "The Proper Method of Disposing of Sewage and Household Waste in Isolated Buildings Where No Drainage System Can Be Made Available," R. P. C. Sanderson; "An Evaporative Surface Condensor," Jas. H. Fitts; "Brick Pavements," Wm. M. Dunlap; "The Improvement of Virginia Highways," H. W. Newby; "Municipal Building Laws," Clarence Coleman.

L. J. Carmalt, Secy.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—At the meeting on June 13, 30 members and visitors present, Mr. James Ritchie read a paper on "Preliminary Surveys for a Railway Line."

Frank C. Osborn, Sec'y.

COMING TECHNICAL MEETINGS.

ASSOCIATION OF ENGINEERS OF VIRGINIA.
June 30, July 1. Secy., L. V. Carmalt, Roanoke, Va.

ENGINEERS' CLUB OF PHILADELPHIA.
July 1. 1122 Girard St. Secy., L. F. Rondinella.

SWEDISH ENGINEERS' CLUB.
July 1. Secy., P. Valentine. At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.

ENGINEERS' CLUB OF ST. LOUIS.
July 5. Secy., Arthur Thacher, Odd Fellows' Building.

WESTERN SOCIETY OF ENGINEERS.
July 5. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

ENGINEERS' CLUB OF MINNEAPOLIS.
July 6. Secy., E. Nexsen, 504 Kasota Block.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
July 7. Secy., F. K. Smoot, 803 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
July 7. Secy., O. Von Geldern, 719 Market St., San Francisco.

MONTANA SOCIETY OF CIVIL ENGINEERS.
July 8. Secy., G. O. Foss, Helena.

ENGINEERS' CLUB OF KANSAS CITY.
July 10. Secy., Waterman Stone, Baird Building.

WISCONSIN POLYTECHNIC SOCIETY.
July 10. Secy., M. F. Schinke, City Hall.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
July 11. Secy., F. C. Osborn, Case Library Bldg.

NORTHWEST RAILROAD CLUB.
July 11. Ryan Hotel, St. Paul. Secy., W. D. Crosman.

NORTHWESTERN SOCIETY OF ENGINEERS.
July 11. Secy., D. W. McMorris, Burke Block, Seattle, Wash.

DENVER SOCIETY OF CIVIL ENGINEERS.
July 11. Secy., F. E. King, Jacobson Block.

CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
July 12. Wichita, Kan.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
July 13. Secy., F. W. Mowbray, Norton Building.

ENGINEERING ASSOCIATION OF THE SOUTH.
July 13. Secy., W. G. Kirkpatrick, Nashville, Tenn.

TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
July 14. 201 Washington Building.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
July 14. Secy., D. W. Meeker, St. Paul.

COLUMBIAN ENGINEERING SOCIETY.
July 18. Secy., F. W. Hart, Washington, D. C.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
July 18. Secy., E. H. Clark, Pittsburg.

BOSTON SOCIETY OF CIVIL ENGINEERS.
July 19. Secy., S. E. Tinkham, 36 Broomfield St.

NEW YORK RAILROAD CLUB.
Sept. 21. Secy., John A. Hill, Temple Court, N. Y.

ENGINEERS' CLUB OF CINCINNATI.
July 20. Secy., J. F. Wilson, 24 W. 4th St.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
July 20. Secy., C. F. Franson, Portland Block.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
July 28. Secy., C. H. McLeod, Montreal, P. Q.

AMERICAN INSTITUTE OF MINING ENGINEERS.
July 31 to Aug. 5. Chicago, Ill. Secy., R. W. Raymond, 1 Burling Slip, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
July 31 to Aug. 5. Annual Convention at Chicago. Secy., F. Collingwood, 127 East 23d St., New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
July 31 to Aug. 5. Annual Convention at Chicago. Secy., F. R. Hutton, 12 W. 31st St., New York.

ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Sept. 5. Secy., W. Halliburton.

NEW ENGLAND RAILROAD CLUB.
Sept. 13. Secy., F. M. Curtis, O. C. R. R., Boston.

WESTERN RAILWAY CLUB.
Sept. 19. Secy., Clement F. Street, Chicago.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Sept. 21. Secy., S. A. Charpiot, Macon, Ga.

CENTRAL RAILWAY CLUB.
Sept. 27. Secy., S. W. Spear, Buffalo, N. Y.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Oct. 2. Secy., C. L. Annan, City Engineer's Office.

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon: new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The headquarters of Engineering News, on the grounds of the World's Columbian Exposition, are at Section K, Aisle 37, of Machinery Hall (central aisle, just west of the large water tank), and at Section U, Posts 10 to 12, of the Transportation Building Annex, at west end of Great Britain railway exhibit. For the convenience of subscribers and advertisers, it is announced that some member of the editorial staff of this journal may be found at the first-named office, in Machinery Hall, from 10 to 10:30 a. m., of each week day, and from 10:30 to 11 a. m. at the second-named office, in the Transportation Building, as also frequently at other times. Appointments may be made by calling at our downtown Chicago office in the Monadnock Building.

One entire session of the Master Mechanics' Convention last week was devoted to a discussion of the question, How can firebox steel be tested? We have abstracted the discussion in another column, but some of the facts which developed in it are worth more extended notice. It is safe to say that at the present time the firebox causes more tribulation and expense than any other part of the locomotive. Boiler repairs now form a good share of the total cost of keeping locomotives in running order; and boiler repairs are chiefly repairs on the firebox. There is a very general belief, and it is probably a correct one, that the life of fireboxes is much shorter now than it was 20 years ago. There is also a very general belief that the cause of the shorter life nowadays is that the steel is not as good as the favorite brands of steel or iron which were in use a score of years ago. It is doubtful whether there is any foundation for this idea. The steelmakers do not take pains to contradict it for it affords them an opportunity to preach against the practice of buying material on specifications in the open market. When the master mechanic says that steel is not as good as it used to be the steelmaker replies: "How can it be when prices are so much lower? If you will put your trust in me, and pay my price for good steel, I will make it for you." It is the old story of manufacturer's reputation vs. engineer's specifications, in the purchase of material. It was most refreshing to have the fact plainly brought out in the master mechanics' discussion that railways which were relying on the reputation of old favorite brands were being badly disappointed, while railways which were buying material on modern specifications were having comparatively little trouble with their fireboxes.

Really, when we consider the acknowledged great advance made in structural steel manufacture and the fact that the entire art of making soft steel has developed in little more than a quarter of a century we see the absurdity of the idea that firebox steel manufacture is a lost art.

But, if firebox steel is as good or better than it used to be why do fireboxes fail in so much shorter a time? The reasons as given in the discussion were, first, the fact that a locomotive makes twice or three times the monthly mileage that was made a score of years ago; it runs faster, works harder, burns coal more rapidly, heats its plates hotter, and, last, but not least, uses a great deal poorer water than the locomotives of a score of years ago. One speaker in the discussion said that since the forests had been cut off the rivers were muddy in rainy weather and in dry weather were kept up mainly by springs which carry usually more or less scale forming matter. It is to be also remembered that in the early days of railroading, to which many of those who are now having trouble with fireboxes look back, the railways of the country were mainly in the East where pure water abounds. Trouble with staybolts, firebox sheets, etc., appears to be little heard of now among the railways of New England. It is those in the limestone regions of the West and South that complain.

Of course all these modern conditions of locomotive operation must be met; but such portion of the trouble as is due to hard water can be avoided by purifying the water for locomotive use. The argument against doing this has always been that the saving was not enough to warrant the expense. But if we are to judge by the experience of the man who said in the discussion that his passenger locomotives required three new fireboxes in five years' service, or the one who said that for even a small increase in the durability of steel plates the railways could afford to pay double the present price per pound—if these things are true, then the gain by pure water would certainly warrant a large expenditure to secure it.

We hope every one of our readers who has anything to do with trade catalogues will give careful consideration to the present movement toward the adoption of a standard size for such publications, 6×9 ins. The adoption of this size is already so general that it is practically certain to go steadily forward. The first formal action in this direction, so far as we now recall, was that taken by the Master Car Builders' Association recently; but to show how near the pamphlet library of an engineer already comes to this standard size, we would call attention to the numerous publications which now conform to it. This list includes the proceedings of the four national engineering societies, Civil, Mining, Mechanical and Electrical, the "Journal" of the Association of Engineering Societies, and the publications of the Engineers' Club, at Philadelphia, Pittsburg and San Francisco, all the state engineering societies which we recall, the Canadian engineering societies, and the most important of English engineering societies except the Institution of Civil Engineers, which has slightly smaller "Proceedings," but not enough smaller to make its filing very inconvenient. Among the railway associations the Master Car Builders', Master Mechanics' and Road Masters' (the American Association), conform to the standard. The Superintendents' report is somewhat large and the railroad club and New England Roadmasters' reports are very small and inconvenient. Both the New England and the American Water-Works associations' reports are correct in size, and so is the Iron and Steel Association's pamphlet of statistics. At least 90% of the municipal reports and a majority of the railway corporation reports received at this office are approximately of the above size.

There are doubtless numerous others; but the above list is quite sufficient to show that the size of shelves and cases for a model engineers' pamphlet library is already pretty well fixed. It is well worth the while of manufacturers to consult the convenience of their customers by adopting this standard size where they have not already done so. At present the disparity in sizes is great enough to deter many from filing their trade catalogues in form convenient for reference, who would otherwise do so. As a general rule, the heavy purchaser of supplies is not the man to be attracted by fantastic forms or sizes or eccentricities of binding. It is important to him that all his catalogues of pumping machinery, for example, shall go into one case, and if nine fit in nicely and the tenth is an awkward oblong book which is stowed away on a top or bottom shelf for lack of a better place, no one is especially apt to remember it when it is wanted, and the order will be apt to go to one of the nine firms whose goods most nearly meet the requirements. At present it is safe to say that not half the business houses in the country have a convenient and systematic method of filing trade catalogues, and the loss and inconvenience due to this is often considerable.

If any of our readers have at present no satisfactory system of filing pamphlets, a word as to the system which has gradually been developed in the office of this journal may be of interest, as it is in some respects unique. Neither the "file cases" sold by stationers nor the ordinary pamphlet cases are used. The former are too much bother to get into, the latter are too small in every dimension. Instead of either, plain pasteboard boxes 10¼ ins. high, 8 ins. deep (from front to back of the shelf) and 4 ins. broad are used. These are strengthened with cloth at the corners and are substantial enough to stand considerable handling, yet they are very cheap, costing only 60 to 75 cts. per dozen. The front of the case (or side toward the back of the shelf) is left open, or a cover can be used for it if desired. The back of the case (like the back of a book) carries the label describing the contents, type-written on it, and on this broad back additions or erasures can be easily made.

In these cases the classified pamphlets are placed; and of course on the classification adopted the convenience and usefulness of a pamphlet library will largely depend. Every office will naturally make its classification to suit its needs; but the plan we have followed with much success is to make two classifications, a general and a sub-classification. Thus the pamphlet library is first of all arranged in departments, the titles being "Railways," "Mechanical Engineering," "Municipal Engineering," "Structural Engineering," etc. Each of these departments has certain shelves assigned to it, and on these shelves the pamphlet cases are ranged after the sub-classification is complete. To facilitate reference, the cases containing matter coming under one general head are kept together. Thus, in the Railway department all the cases containing matter relating to car-heating, brakes, draft gear, etc., are kept together as belonging to the one general subject of car rolling stock. It is a mistake, however, to classify any more than the number of pamphlets makes necessary. For example, if all the catalogues relating to railway rolling stock and appliances will go in one case, they should be put there. It is much easier to slip the pamphlets out of this case and run them over to find a catalogue of car seats, for example, than to hunt over a half dozen cases, in doubt as to which one it should properly be found in.

One of our contemporaries was recently much exercised concerning the high price of aluminum, and devoted some space to an argument that before any great demand for the metal could be expected the price must come down. We showed in our issue of Feb. 16 that aluminum at 50 cts. per lb. is nearly as cheap as copper, bulk for bulk; and the fact has recently been brought to our attention that the supply of aluminum is not now equal to the demand. At present prices of about 80 cts. per lb., an advance of 30 cts. over the price at which it was sold a few months ago, the metal cannot be manufactured fast enough to fill orders. A member of the staff of this journal recently received from a personal friend a request to obtain for him, if possible, a few hundred pounds of the metal. But on extended inquiry he found it impossible to obtain for immediate delivery even so small a quantity as 100 lbs. of the metal anywhere in New York city. It appeared that users of the metal were calling for it faster than the manufactories could turn it out. Evidently there is no necessity of hunting for new uses for the metal in order to find a market for the works at present in operation.

PRACTICAL TESTS OF MODERN WAR-SHIPS.

With the exception of the "Kearsarge" and the "Hartford," two wooden ships of the old type, and the Chilean "Huascar," there is not now afloat a

single man-of-war of any nation, we believe, whose efficiency has been tested in battle. Practically speaking, the navies of the world have been built up in an era of peace within the last 30 years, since the "Monitor's" exploits revolutionized naval shipbuilding.

It is obvious that this has been a severe test of the abilities of naval designers. The natural test of any mechanism is subsequent continuous use in the functions for which it was designed, and in every other field of work except naval designing this is the principal if not the only reliance of the designer for making each successive work an improvement on the last. Without this crucial test real progress would be all but impossible. Suppose, for example, that the conditions had required that great fleets of "ocean greyhounds" should be built and kept on hand, not for actual use, but for the contingency that they might at some time be needed. What likelihood is there that the "Campania" and "Majestic" and "Paris" would have been really the splendid boats for this service that they are in every detail? What likelihood is there that their officers would then really have known how to handle them well in such service? What likelihood that their appointments would really have been suitable for it, or that their engines or engineers would have proved equal to the emergency when they were suddenly called upon to discharge functions which neither they nor any other living person had ever discharged before? Is it not more than likely that the first demand for real service would show that neither the men nor the ships were really equal to the service? that supposed improvements were really injurious, and supposed necessities really unnecessary, while real necessities had been overlooked?

Such, it seems to us, is the present sfatus of the navies of the world, and the late terrible disaster to the "Victoria" is only an evidence thereof. A vessel supposed to be almost impregnable, almost if not quite the most powerful weapon of offense afloat, is shown to be as helpless as a canal-boat against collision with another heavy vessel; and as all these massively armed ships are comparatively slow it seems to follow of necessity that all ships of that type are at the mercy of considerably smaller ships which are a knot or two faster and which cannot be sunk at once by two or three heavy shots. That the disaster will have an immediate and great effect on naval shipbuilding, and give a great stimulus to the construction of vessels like Admiral Ammen's ram, seems assured; yet, who can tell that the next accidental or warlike conflict between two ships of war may not point to precisely opposite conclusions? Not from a single test, but from a general average of many different tests, can the best practice in the designing of anything be determined. Above all, we should avoid the absurdity and unmanly injustice of charging any such occurrence to general inefficiency or lack of discipline in the service which happens to be so unfortunate. It is in the nature of things unavoidable that navies produced as all existing navies have been produced, by evolution from the inner consciousness only, and not by the natural process of struggle for existence and survival of the fittest, should have many defects. Which service has most defects can only be guessed at, except that it is a tolerably safe bet that the service which has most ships afloat has the most very poor ones for real warfare. We have long been of opinion that the next great naval war would have some painful surprises for both contestants, and we look on this last disaster as tending to mark that fact. It is a hard saying; but if England would maintain her supremacy on the sea, and have any assurance of it, the only safe course for her is to pick a quarrel with some weaker naval power, and let some of her ships be tested in actual warfare. They had been thus tested for centuries up to Nelson's time, and yet the war of 1812 revealed the fact that they were anything but perfect even then. So far as the United States is concerned, the moral of the late occurrence is rather hopeful than otherwise. Powerful rams for harbor defence and swift cruisers like the "Pirate" are indicated for the bulk of her navy, and we shall be surprised if events do not follow this indication; but whether this is really the wiser course is yet, as we have stated, an open question.

GOOD ADVICE TO ENGINEERING GRADUATES.

A late address to the graduating class of the engineering department of the University of Kansas, by Mr. J. A. L. Waddell, contains some very sound advice to embryo engineers, and we abstract some of these points, as follows:

In referring to the position taken even by engineers that engineering is not, strictly speaking, a profession on account of its affiliation with contracting and business, Mr. Waddell remarks that one might as well maintain that law is not a profession, on account of its connection with criminals, or that medicine is not a profession because surgery is very similar in some respects to the occupation of a butcher. Engineering is, indeed, a learned profession, and each year is becoming more so in its wider application of the sciences to the needs of construction.

Students, just about graduating, are too prone, in seeking for a start in their professional life, to gage the positions offered by the salary that accompanies them. While this is natural, Mr. Waddell warns them that it is altogether wrong in principle and that the converse of this choice has usually the best effect upon ultimate progress. The highest salary paid to a graduate under these circumstances may be taken at $100 per month, and this only in flush times. This offer generally comes for the work of a surveyor, as elementary surveying is the only practical work on which the graduate is posted. There is little to be learned and less of a professional future in work of this character, and when the "boom" has passed the young engineer who is properly ambitious finds that he has only been wasting time.

Railway location and construction offer a better field to the recent graduate, and he may really earn $40 to $50 a month and his subsistence by hard manual labor in dragging a chain or driving stakes. But while he is spending a great deal of time in a manner profitable to his employer, and is gaining some experience, it is not experience of a high grade, nor great in amount. On the other hand, this work is profitable after all to the student released from a sedentary, college life. The active exercise in the field is just what he wants mentally and physically, and better fits him for the years of hard work and study that fall to the lot of all engineers. There is a fascination about this out-of-door life, and the engineer's early experience in the mountains or on the plains will remain through life as a pleasing memory.

There are various other lines of engineering where the inexperienced man can earn a bare living at office work. But the pay is necessarily small, because this work can be done by a swarm of cheap draftsmen, who are generally worth no more than they get. While such positions eventually lead to something higher for the earnest worker, the young engineer must expect to do much drudgery in order to earn even the small pay he receives. But he is learning to put his ideas on paper rapidly, and to make a presentable drawing, and he is picking up ideas on structural detail, or points in location, etc., that he cannot well find elsewhere, and that will be of great use to him in the future. The only caution to be given is that he should not do so much of this work as to become a mere drafting machine.

One of the best places for the real future of the young engineer is employment in the office of an engineer of well established practice in the higher branches of engineering. To this employer his services are worth absolutely nothing to begin with; and more than that, his employer must devote considerable time, time that is worth dollars and cents, to instructing the student in fundamental principles and practical methods. But the young man who means to succeed is learning almost every hour something that is of great value to him, and at the end of a month he will have acquired a greater amount of useful knowledge than he would in a year of ordinary routine work at a fair salary. In an office of this kind the beginner usually receives no salary at all; in England he has to pay for his privileges, and Mr. Waddell thinks the time is not far distant when the same practice will hold good in the United States. But the wise young engineer will seek employment in the best office of this kind available, in preference to the salaried position referred to.

As to a choice of a particular branch of the profession of engineering, Mr. Waddell very properly says that the young graduate is very rarely in a position to make this choice. He has had as yet very little opportunity to really see what the various branches are and in what their work consists. There is no branch of engineering that is separate and distinct from all other branches, and the more general the experience obtained in youth, the greater will be the man's capacity and the broader his mental grasp during his best working years. For these reasons Mr. Waddell advised his hearers not to select "a specialty" at once, but rather to spend a few months, or at most a year, upon one class of work and its details, and then to take another and another until their experience in general engineering was as wide, comprehensive and thorough as possible. Meanwhile, they should scan the field and select some special branch of engineering toward which circumstances or natural capacity seem to point; they should let their studies and practice tend continually more and more toward that chosen line, and when opportunity presents itself eventually abandon all others and make the chosen one a life work.

Young engineers must be content for a while to earn a bare living, but should see to it that they are obtaining meanwhile the experience they need and have let no opportunity escape them for gaining useful knowledge. This latter is their real capital, and those who have gathered a varied amount of it will find that in middle life they will outrank those who started with them in life and adopted the policy of confining themselves to one line of work and thought, and by so doing resolved themselves into men with but one set of ideas.

To the men who cannot take this advice, but must accept the first offer that comes in order to pay off indebtedness incurred in obtaining an education, or to support a family, Mr. Waddell points out the importance of extensive technical reading in other branches of the profession than the one engaged in. In this way they can prevent stagnation and keep themselves in touch with the things outside of their special line of work. Above all things he advised his student hearers not to leave the University with the idea that they had completed their technical education. This education had merely begun; and while they might earn a living without further study, said Mr. Waddell, they could never attain professional distinction without further and continuous study. While it is hard work, it is yet practicable to carry on a course of technical reading even when one has to work long hours in the office or in the field. One of the best methods to do this is to take a certain treatise, mathematical or otherwise, and arrange to read it through, thoroughly and understandingly, in a certain number of days, laying out beforehand the amount of each day's reading. This amount should be based upon the average time available, and the character of the book. If for any reason the allotment for one day cannot be completed, take an extra portion next day, and when the chance occurs read ahead of the allowance so as to anticipate possible interference. It is a good practice to carry some technical book in the pocket to read at odd moments, when waiting for a train, or on the train, or at the noon-hour in the field.

It is essential to a young engineer that he reads the principal technical periodicals and the transactions of the engineering societies, so that he can keep up with the times. Mr. Waddell cautioned his hearers that an article is not necessarily valuable because it is intensely mathematical. As a rule most of the mathematical papers on engineering subjects are mere rubbish, though occasionally a good paper appears. This warning is not against mathematics itself, which is invaluable to the engineer, and the study should be always kept up; but the student must learn to sift matter of this kind for himself and avoid wasting valuable time upon investigations too often founded upon mere assumption or utterly false data.

In his course of reading, standard literary works should be included, for the purpose of improving his style in writing, for most writers on engineering subjects have much to learn in this direction. The young engineer will always find it profitable to add his mite to engineering literature, but should only write when he has something to say, and then say it plainly. The most valuable information that comes to the profession is in the form of con-

tributions to engineering societies or the technical press, describing works completed or in progress with all the difficulties encountered and the methods of overcoming them. Every paper of this kind, with the discussion it provokes, marks not only a step forward in constructive progress, but it also indicates the next steps to be taken. In such papers express your ideas clearly and tersely, cut out all mere padding, for the time of engineers is valuable, and before you begin ask yourself if the paper will in any way prove useful to the profession. If the answer be in the affirmative, write the paper; if not, don't. There is nothing that will so favorably introduce a young engineer to his professional brethren and to the public generally as a good, sound technical article, written for an engineering society or a technical journal. Don't be ambitious to write a book; and never write one unless you are sure there is need for it and that you have exactly the right kind of information to put in it, and then don't expect great financial profit.

Mr. Waddell advised the especial study of specifications and contracts for engineering work so that the engineer may learn how to prepare them so as to cover the ground in a satisfactory manner. Legal decisions and the law of contracts are of interest to engineers, and business methods should be closely studied, including the keeping of accounts. The young engineer should never be too proud to learn from the most ignorant in most other things; the man who handles the pick and shovel can give valuable information concerning earthwork, and the stonecutter and quarryman often know things not found in books.

The graduates were advised to at once enter the American Society of Civil Engineers as Juniors, and advance as fast as possible, and also to join any local engineering society available. As to general bits of advice, they were to be earnest in all work; methodical in practice, checking and counterchecking to avoid mistakes; not to be discouraged by failure; to make as many acquaintances as possible among engineers, and establish themselves on a friendly footing with a few prominent members of the profession, so that they can go to them for advice; not to hesitate to ask when they did not know and to be ready to help another engineer from their store of experience, even if it was limited; and to avoid all petty professional jealousies, and remember that to rise in the world it is not necessary to push others down.

As regards engineering ethics, now much discussed, Mr. Waddell said that the importance of this subject cannot be over-estimated. The engineering profession needs a code of ethics in order to raise itself in the public estimation to the position it ought to occupy. This will take time, but it must come, for engineering is destined to lead all professions in the progress and development of the civilized world. In the meanwhile, each engineer should adopt a little code for himself, consisting of one principle—"To deal squarely by everybody under all circumstances." If he places himself mentally in the other man's place, his judgment as to what is right cannot be far wrong.

The engineer in charge of construction is an arbitrator between his employers and the contractor, and is not the oppressor of the latter. The salary paid does not purchase the engineer's conscience, and he should look out as carefully for the rights of the contractor as for those of his employer, and he should aid the contractor in every legitimate way. If the contractor is losing money, the chances are he will slight the work; and in letting work it is bad policy to award a contract to any competitor for less than actual cost plus a living profit.

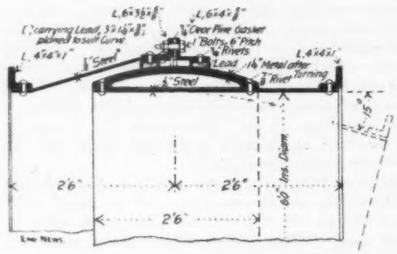
In conclusion, Mr. Waddell points out the great importance of systematizing work, and notes the fact that the most successful engineer is the man who can obtain the greatest amount of intelligent work from those he employs. He also advises young engineers that there are other things in life than professional advancement and success; that it is bad policy to reduce one's self to a mere working machine, which is liable to break down or run badly from want of a little lubrication. Every hard working man is entitled to an occasional holiday, and the reviving effect of this vacation will enable him to work all the harder when his play is over. A man is also under certain obligations to his fellow-men, and he should strive to make himself agreeable to those about him; those employed by him will be all the more useful and the machine will run easier by reason of good, fair treatment and general kindness on the part of the employer.

LETTERS TO THE EDITOR.

A 72-IN. FLEXIBLE STEEL JOINT FOR THE WATER-WORKS OF TORONTO, ONT.

Sir: I notice that in your issue of June 15, in an article upon "The 54-In. Steel Submerged Pipe for the Syracuse Water-Works" you illustrate a universal flexible joint. In the closing paragraph of the article referred to the author says: "I wish to state that much credit is due to Mr. Howard Soule, Consulting Engineer of the Syracuse Water-Works, for the preparation of the specifications and for the design of the joint used in this pipe."

If the latter part of the paragraph refers to the flexible joint, then I beg to differ with the writer of the article. The joint in question was designed by me and submitted to the Toronto water-works department and accepted by them in the early part of 1888, for whom I built 90 joints; 65 of the joints were for 48-in. pipe and 15 for 60-in. pipe. The latter I believe



72-in. Flexible Steel Joint; Toronto Water-Works.

to be the largest flexible joint ever made. I also inclose a sectional view of some joints, shown herewith, our firm (the Central Bridge & Engineering Co.) are now building for the city of Toronto for a 72-in. pipe, to be laid in Lake Ontario in connection with their water supply. This print shows the joint in detail, and will illustrate my claim to be its designer.

All my joints have been of this same design, and they have proved to be almost indestructible. During this past winter the conduit was pumped dry and floated, several of the joints protruding through the ice several feet; the ⅜-in. steel sheet of the pipe was ruptured in several places; some at the seams by the shearing of the rivets, and others by the tearing across the holes; but the flexible joints remained firm, and have since been relaid.

I am pleased to say that several engineers in the United States have written to me for prints and other particulars, therefore I suppose they have understood that I was the first to design and manufacture this steel tube flexible joint.

In an article upon the Toronto water supply that appeared in your paper some two years ago (Oct. 17, 1891) you then mentioned the fact of my having constructed the flexible joints for said conduit.

If there is any merit in the device I believe I am entitled to be credited with the same.

Wm. H. Law, C. E.

Peterboro, Ont., June 21, 1893.

(There were two joints used at Syracuse and described in the article referred to above, the flexible joint, to which Mr. Law refers, and a hook-bolt joint. In crediting Mr. Soule, the author of the paper did not state which joint he meant. The original from which the illustration of the 60-in. flexible joint at Toronto, shown in our issue of Oct. 17, 1891, was made did not show the details of the joint so clearly as does the accompanying section of the 72-in. joint, and lacked dimensions.

A comparison of the section of the Toronto joint, as shown above, with the Syracuse joint, in our issue of June 15, shows that the differences between the two joints are mainly in the dimensions of the parts and in the bearing surfaces, the Syracuse joint having the greatest area of bearing surface. The Toronto joint has a possible deflection of 15° in any direction, against 12° in the Syracuse joint. For ordinary joints at Toronto flanges and bolts are used, while at Syracuse the hook and bolt joints described in our issue of June 15 are used.—Ed.)

STEAM SHOVELS AND STEAM SHOVEL WORK.

Sir: I have read with a great deal of interest the series of articles by Mr. Hermann on "Steam Shovels and Steam Shovel Work," now being published in Engineering News. Will you kindly place my name on file in case these articles are republished, so that I can get a copy of the book. I presume from the fact that the article is copyrighted that it will appear later in book form. Walter G. Berg, C. E.

Jersey City, N. J., June 19, 1893.

(The articles on "Steam Shovels and Steam Shovel Work," by Mr. E. A. Hermann, now being published in this journal, will be entirely reset for publication in book form. About two-thirds of the article have been published already.—Ed. Eng. News.)

SURVEYS AND BORINGS FOR THE PRINCE EDWARD ISLAND TUNNEL.

For some years the Canadian government has been considering the construction of a tunnel under the Straits of Northumberland to secure better connection between the mainland of New Brunswick and Prince Edward Island. At present the only connection is by steamer lines, two of which are subsidized by the government, and for from two to three months of the year these are inoperative on account of the ice. During these winter months the only communication is by iceboats which convey the mails across the strait, and whose daily trip is uncertain at the best, and ofttimes impossible. The result has been to create more or less complaint among the residents of the island, of which, it may be said, that one of the stipulations upon entering the Dominion in 1872 was that the government should secure daily communication between it and the mainland. This dissatisfaction finally developed into a complaint to the Crown, which led the Canadian government to turn its attention toward the construction of a tunnel. This, while a totally unfeasible scheme from a commercial view, has a more plausible look when considered politically, especially since it is stated that the present annual expense of securing communication would go far toward paying the interest on the capital required to construct a tunnel. Even so, however, the construction of a submarine railway tunnel nearly 8½ miles long is no insignificant undertaking for a government already overburdened by subsidies for public improvements, especially if such a tunnel be admittedly unprofitable from a commercial standpoint, and it may be justly doubted whether in the present case the "game is worth the candle."

The first definite move made by the Canadian government toward the construction of a tunnel was in 1886, when Parliament appropriated a small sum to defray the expenses of preliminary borings and surveys. These borings, which were in fact little more than the examination of the bottom of the straits by sounding-rods, showed, according to the report of the Minister of Railways and Canals for 1889, sand, gravel and clay, with rock in places, and a maximum depth of water of 96 ft. About this time a project for sinking a metal tube to the bottom of the straits through which trains could be run was developed, and this overshadowed the tunnel scheme for some years. In 1891, however, the government employed Sir Douglas Fox, M. Inst. C. E., to report upon the feasibility of a tunnel across the straits. In his report Sir Douglas Fox asserted the feasibility of the tunnel from an engineering standpoint, but recommended that before any definite steps were taken a series of deep borings should be made to determine exactly the character of the material which would be penetrated. Accordingly, borings were made in 1892, by Mr. Alfred Palmer, Assoc. M. Inst. C. E., who presented his report on the work in January of this year. We have prepared the following description of the method of conducting the work and the results obtained, from this report and from information furnished us by Mr. Palmer.

The line selected for the tunnel was from Money Point, on the New Brunswick shore, to Carleton Point, on the Prince Edward Island shore. This line is the shortest between the mainland and island. The shores upon both coasts are well adapted to the construction of the tunnel approaches, since from an elevation of about 30 ft. at the shore the land declines toward the interior to an elevation of about high-water level. The soil is a red clay. About 5½ miles of railway would

be required to connect the railway systems of New Brunswick and Prince Edward Island with the tunnel line. At this point it may be noted that while the New Brunswick railways are standard gage, the entire system of Prince Edward Island is 3 ft. 6 ins. gage, which will necessitate either the breaking of bulk at one end of the tunnel or the changing some 210 miles of railway on the island to standard gage. The distance between Money Point and Carleton Point was calculated on the line of arc and is 40,716 ft., or 7.71 miles, while the length of the tunnel will be 44,724 ft., or 8½ miles. This route is shown in Fig. 1, which also shows the line of deepest soundings, the two 5-fathom contours, and the line of soundings between Cape Tormentine and Cape Traverse, all reduced to the same datum, viz., the lowest spring tide level at Cape Jourimain as determined by the government engineers, who considered the positions of the heavenly bodies really producing the tides as well as the other agents, such as the atmospheric pressure, temperature, velocity of the winds, etc., affecting them.

The line of borings was taken just north of the Formation No. 2, or the productive coal measures, is apparently wanting in the vicinity of the Northumberland straits at this point. It will be seen that everything points to a very favorable material for sub-aqueous tunnelwork. The principal question is whether shafts can be sunk in the deep water of the straits, as proposed, with safety. Undoubtedly they could be made reasonably secure against damage from ordinary causes, but if we are not greatly mistaken wandering icebergs of small size are by no means infrequent in the straits, and there are always chances of trouble from anchor ice. Upon the possibility of using shafts the construction of the tunnel within a reasonable limit of time will depend. In Fig. 2 is shown a profile of the tunnel proposed in the report, and in Fig. 3 two proposed sections. This plan provides for a tunnel 38 ft. wide, and 18 ft. high from the base of rail to the crown of the arch, with a lining of either cast iron segments or brick masonry. It is proposed to sink five caissons to act as temporary shafts. These caissons are to be composed of two concentric iron or steel cylinders with the annular space between them filled with concrete,

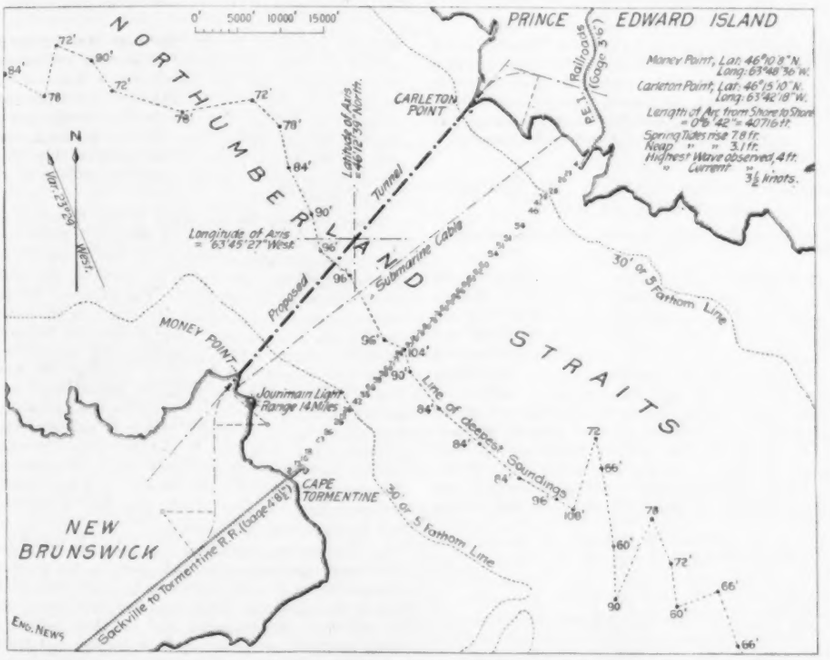

NORTHUMBERLAND STRAITS
PRINCE EDWARD ISLAND
NEW BRUNSWICK
CARLETON POINT
MONEY POINT
CAPE TORMENTINE
Jourimain Light Range 14 Miles
Money Point, Lat. 46°10'8" N. Long. 63°48'36" W.
Carleton Point, Lat. 46°15'10" N. Long. 63°46'18" W.
Length of Arc from Shore to Shore = 7.71 mi. = 40716 ft.
Spring Tides rise 7.8 ft.
Neap " " 3.1 ft.
Highest Wave observed, 4 ft.
Current " 3½ knots.
Latitude of Arc = 46°12'39" North.
Longitude of Arc = 63°45'27" West.
Var. 23°29' West.
Tunnel
Proposed
Submarine Cable
Line of deepest Soundings
30' or 5 Fathom Line
Railroads
P.E.I. (Gage 3'6")
Sackville to Tormentine R.R. (Gage 4'8½")
ENG. NEWS

FIG. 1. MAP OF PROPOSED TUNNEL UNDER THE NORTHUMBERLAND STRAITS, CONNECTING NEW BRUNSWICK AND PRINCE EDWARD ISLAND.

tunnel line. Ten borings were made varying from 60 ft. to 184 ft. 8 ins. in depth. Six of these were deep sea borings, and the other four were located one at high water and one inland on each of the opposite shores. The character and depths of the different strata encountered in each boring are fully shown in the accompanying table. An analysis of these gives a proportion in the strata of one part of hard impervious clay shale to one part of compact red sandstone, with specific gravities of 2.59 and 2.23, respectively. As will be seen from the borings, there is much false bedding. With the exception, however, of one or two thin beds of brown sandstone, which showed a slight leakage, all the strata appear impervious to water. The six deep sea borings averaged 60½ ft. in depth and the borings at high water on the opposite shores were 140 ft. and 184 ft. 8 ins. deep. The position of each was determined by triangulation.

The geological formation through which the tunnel will penetrate is the Upper Permo-carboniferous consisting of red sandstone and red clay shale in approximately equal proportions, the latter being impervious to water. This Upper Permo-carboniferous formation rests upon the well known millstone grit formation, the exact order being: (1) Upper Permo-carboniferous; (2) productive coal measures; (3) millstone grit; and (4) lower carboniferous and will be sunk on the center line of the tunnel, as shown in the illustration. The various dimensions, grades, etc., are also clearly shown in the illustration.

An interesting point brought out in the work is the possibility of making diamond drill borings in depths of water up to 100 ft. with practically as much ease and certainty as they can be made on

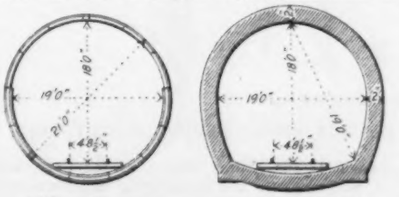


Fig. 3. Proposed Sections for the Prince Edward Island Tunnel.

land. In commencing the work it was at once found necessary to devise some apparatus sufficiently strong to withstand the force of the three and a half knot current, practically 36 lbs. per sq. ft., and the effects of the heavy seas during storms. As will be seen at once, it was necessary that this

Table Showing Material Encountered in Borings for the Proposed Tunnel Under the Northumberland Straits, Connecting New Brunswick and Prince Edward Island.

Boring No. 1. (800 ft. Inland from New Brunswick shore, 44 ft. above high water.)	ft.	Boring No. 2. (High water mark New Brunswick shore.)	ft.	Boring No. 3. (1,500 ft. out from New Brunswick shore.)	ft.	Boring No. 4. (3,000 ft. from New Brunswick shore.)	ft.	Boring No. 5. (4,500 ft. out from New Brunswick shore.)	ft.	Boring No. 6. (6,000 ft. from New Brunswick shore.)	ft.	Boring No. 7. (7,500 ft. from the New Brunswick shore.)	ft.	Boring No. 8. (9,000 ft. from the New Brunswick shore.)	ft.	Boring No. 9. (High water mark. Prince Edward Is'd.)	ft.	Boring No. 9. (continued).	ft.	Boring No. 10. (2,640 ft. Inland on Prince Edward Is.)	ft.
Boulder clay	14	F'ne r'd s'ndst'ne	8	Sand and shells	1	Sand and clay	½	R'd s'nd & shells.	3	Red clay	4½	Sand, gravel and shells	1	Sand and r'd clay	2½	Sand and r'd clay	2½	C'rse red s'dst'ne	8.1	C'rse red s'dst'ne	1½
Coarse gray sand	4	Red cl. sh'le	28½	Red clay sh'le	3½	Brn red calc. s'ndst'ne	1	R'd s'nd & sheils.	½	Calc. conglom.	0.1	R'd clay and s'nd	5	Buff arrn. limestone	0.1	Buff arrn. limestone	0.1	Fine calc.	1	Fine calc.	1
Fine gray sandstone	0.4	F'ne r'd s'ndst'ne	14.6	F'ne r'd s'ndst'ne	1½	Red clay shale	6.8	Br'n r'd s'ndst'ne	2½	Br'n r'd s'ndst'ne	½	Red sandstone	0.5	Red clay shale	3½	C'rse red	.09	C'rse red	5½	Glacial clay	36.1
Dk'k red cl. sh'le	6½	Red clay sh'le	8½	F'ne r'd s'ndst'ne	10.1	F'ne r'd s'ndst'ne	1¼	R'd clay sh'le	2½	R'd clay and s'nd	3.1	Calc. sandstone	0.8	Red sandstone	4½	Red sandstone	6	C'rse red	.5	Red sandstone	11¼
F'ne red s'ndst'ne	1.8	F'ne r'd s'ndst'ne	1.8	F'ne red calc. s'ndst'ne	9¼	F'ne r'd s'ndst'ne	3.1	R'd clay sh'le	2.6	Red s'ndst'ne	1¼	Red sandstone	7.1	Red clay shale	10.1	Calc. conglom.	4½	C'rse loose "	.3	Red clay shale	7½
Dk'k red cl. sh'le	4½	Red cl. shale	1	Red clay sh'le	35½	F'ne r'd s'ndst'ne	2½	Red clay sh'le	1	Br'n s'ndst'ne	1½	Red clay shale	1	Fine argil. sandstone	1½	Red clay shale	1½	Red clay shale	1½	Red sandstone	6½
F'ne br'n s'ndst'ne	3	F'ne r'd s'ndst'ne	1.4	F'ne red s'ndst'ne	2½	F'ne red s'ndst'ne	0.1	F'ne r'd s'ndst'ne	1.9	Calc. r'd sandstone	1.1	Red clay shale	2.6	Br'n s'ndst'ne	1½	Fine br'n s'dstone	6¼	Gray cal. s'dst'ne	1½	Calc. sandstone	1½
Br'n clay sh'le	¾	Gray s'ndst'ne	0.1	F'ne red and br'n s'ndst'ne	1½	F'ne r'd s'ndst'ne	3½	Red clay sh'le	1.1	F'ne r'd s'ndst'ne	3½	Red clay shale	8½	Red clay shale	3½	R'd cal conglom.	0.4	Red clay shale	¾	Soft red s'dstone	½
F'ne brown sandstone	¾	C'rse r'd s'ndst'ne	7½	Red clay shale	1.3	Red clay shale	4.1	Red clay sh'le	0.1	Red clay shale	3½	Red sandstone	2½	Red clay shale	7.1	Red clay and sandstone	9.4	Red clay shale	.4	Calc. conglom.	7½
Br'n sandstone	¾	Br'n calc. sandstone	5.4	Red clay shale	4.1	Red clay sh'le	5½	Red clay sh'le	0.1	Red clay shale	4.1	Red clay sh'le	0.1	Red clay shale	1¼	Red clay shale	2.1	Red clay shale	3½	Red clay shale	3.6
Br'n calc. sandstone	0.9	Red clay shale	30¾	Red clay sh'le	1½	F'ne r'd s'ndst'ne	12.9	Red clay sh'le	5.8	Red clay sh'le	4¼	Argil. r'd s'dst'ne	1¼	Red clay shale	2½	Red clay shale	2½	Red clay shale	11.3	Calc. conglom.	1
Br'k clay sh'le	2.3	F'ne br'n sandstone	1	F'ne br'n and gr'n s'ndst'ne	4	Red clay sh'le	2¼	Argil. s'ndst'ne	2¼	Red clay sh'le	2¼	Red clay shale	4.1	Red clay shale	1¼	Red clay shale	4	Red clay shale	2½	Red clay shale	10
Br'k cl. sh'le	2.5	F'ne br'n s'ndst'ne	7	F'ne r'd s'ndst'ne	3	Red clay sh'le	2.6	Fine r'd s'dstone	3½	Fine r'd s'dstone	3.4	Red clay shale	1½	Fine r'd s'dstone	3.4	Fine red s'dstone	1.8	Red clay shale	1.8	Fine red s'dstone	1.8
8'ft. argil. brown sandstone	21½	Br'n s'ndst'ne	¾	Red s'ndst'ne	3½	Red clay sh'le	1½	Fine r'd s'dstone	3.4	Total depth	61.4	Total depth	60.1	Total depth	61.4	Fine dark r'd s'dstone	5	Fine red s'dstone	1.9	Red clay sh'le	3.1
F'ne argil. brown sand-tone	2.6	Br'n s'ndst'ne	3½	F'ne r'd s'ndst'ne	1½	F'ne r'd s'ndst'ne	1½	Red clay sh'le	1.1							Calc. r'd sandstone	1½	Calc. conglom.	1.1	Total depth	97.6
C'rse gr'y and br'n s'ndst'ne	10.6	Red s'ndst'ne	8¼	Calc. conglom	0.1	Red clay sh'le	1.1	Limestone	0.1							Red clay shale	5	Red clay shale	9¼		
H'rd gray calc. sandstone	0.8	Total depth	140	Red s'ndst'ne	2.6	Argil. s'ndst'ne	3½	Fine r'd s'dstone	3.4							Fine r'd s'dstone	3.4	Red clay shale	9¼		
Brown clay sh'le and s'ndst'ne	2½			Total depth	61	Red clay sh'le	0.1	Total depth	61.4							Gray and red s'd stone	.4	Calc. c'nglom.	0.1		
Total depth	60																	Fine r'd s'dst'ne	7.1		
																		Loose red "	1.8		
																		8 ft. cal. conglom.	2½		
																		Red clay shale	3½		
																		Fine red s'dst'ne	1½		
																		Red clay sh'le	3½		
																		Total depth	134¾		

apparatus should be both rigid and stable, since any movement after the boring was once begun would lead to difficulties and delays. The apparatus designed by Mr. Alfred Palmer to meet these requirements is shown in Fig. 4. It consists of a wrought iron tube 4 ins. in diameter, kept perpendicular on the bed of the sea by means of four 1,000-lb. anchors set at right angles to each other and attached near the top of the pipe. At the top of this tube is fastened a 300-lb. steam diamond drill and a light platform to support the mechanics working the drill. In the shallower places it was preserved, and are now in the possession of the Canadian government.

The method of placing the apparatus just described in position for the boring will, of course, vary with the circumstances of the case. In the work in question a large pontoon having a steam derrick was towed into position and anchored. The larger tube, having been built to the required length, its upper end was attached to the hoisting rope of the derrick and lowered until the free end reached the sea bottom and the pipe assumed a vertical position. The four anchors attached to the pipe were

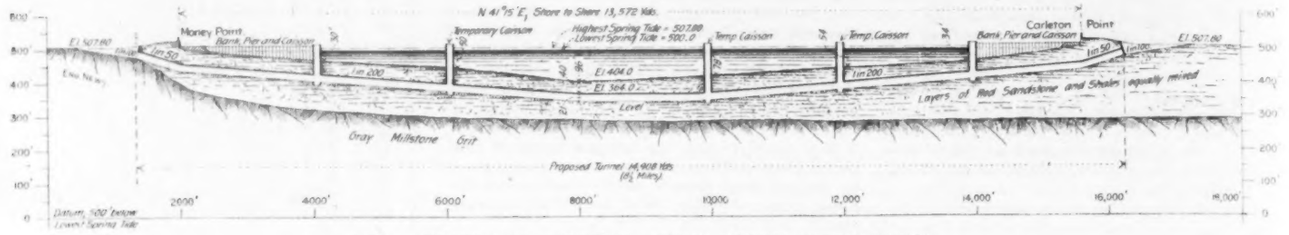


FIG. 2. PROFILE OF PROPOSED PRINCE EDWARD ISLAND TUNNEL.

found that the pipe was sufficiently rigid without bracing, but in depths of water of over 35 ft., it was found necessary to further stiffen the pipe in the manner shown in the illustration, Fig. 4.

In this work it was considered advisable to construct the pipe in sections of 20 ft., using shorter lengths when required. No difficulty was experienced with the joints, which, when properly screwed up with chain spanners, proved to be equally as rigid as any other part of the pipe. It was also found necessary for work in salt water to dip each length of the pipe in boiling tar and to thoroughly grease all joints.

Each of the four anchor lines was fitted with a "watch tackle" for adjusting the pipe in a true vertical position, and a large iron plate is fixed about 2 ft. above the bottom of the pipe to prevent it from sinking into the ground and so slacking up the anchor lines or guys.

After erecting the 4-in. pipe a 2-in. pipe is inserted at the top and driven hard into the ground so as to prevent the entrance of outside water into the boring, as any leakage would, of course, interfere with the accurate observation for hydrostatic head. Inside this 2-in. pipe is placed the drill.

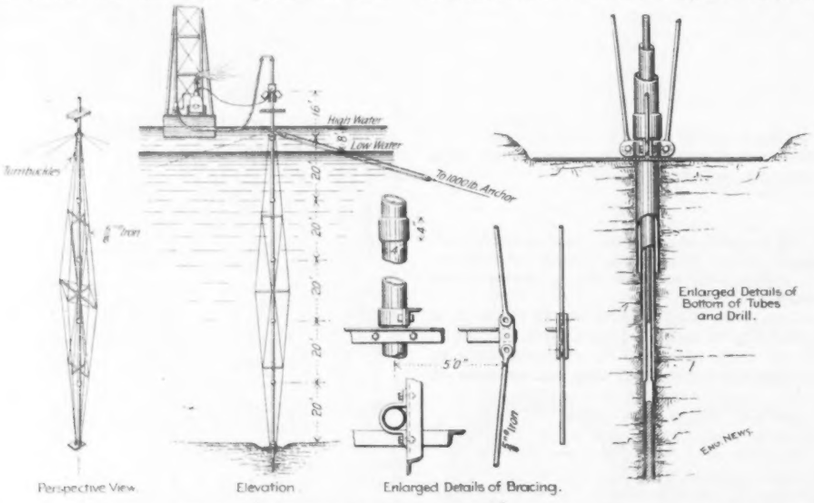


FIG. 4. APPARATUS FOR MAKING DIAMOND DRILL BORINGS, PRINCE EDWARD ISLAND TUNNEL.

The water for lubricating the drill was pumped through a flexible tube down the center of the drill and discharged under great pressure upon the surface of the rock upon which the drill was at work. Both the steam for driving and the water for lubricating the drill were supplied through flexible pipes; the boiler and the pump being located on a scow anchored near the head of the pipe. The drill was operated by an oscillating engine attached to the top of the 4-in. tube and made 1,000 revolutions per minute. The core taken out was 1 in. in diameter. All the cores of the 10 borings made were then placed by small boats and the lines tightened up by means of the "watch tackle" until the pipe was rigid. All that remained to be done then was to place the drills and other mechanism in position. The successful working of the apparatus in very rough water is attested by the engineer.

RAILWAY CONSTRUCTION IN CENTRAL AND SOUTH AMERICA.*

By Wm. E. Curtis, Secretary Pan-American Congress.

None of the topics under consideration by the late International American Conference, except, perhaps, that of commercial reciprocity with the other nations of this hemisphere, have awakened so much interest among the people of the American Republics, and in the world at large, as the proposition to connect the transportation system of North America with that of South America by an intercontinental railway. It is a scheme of enormous magnitude, but not so formidable to the energy of this age as was the construction of the old Cumberland highway between tidewater and the Ohio River, or the Erie Canal, or the Pacific railways, of the United States, at the time they were undertaken. The engineering difficulties are not so great as those which were overcome by the Denver & Rio Grande company in Colorado, and arguments can be advanced in support of the enterprise more forcible than those used by Thomas H. Benton in the United States Senate in behalf of the transcontinental project of 1856.

The government of Mexico is pushing its railways southward with great energy, and the Argentine Republic has been rapidly extending its lines northward until they have nearly reached the Bolivian boundary. Outside of these two countries railway construction has been local and intended only to furnish the productive communities of the interior access to the sea. Chili has a comprehensive system connecting the chief cities with the mines and the coast, and is now piercing a tunnel through the Andes to connect with the trans-Andine road of the Argentine Republic and furnish direct communication between the two oceans. Along the west coast of Central and South America, from the Mexican boundary to the limits of the populated section of Chili, is a series of parallel roads constructed within the last quarter of a century, extending from the several seaports to the mining or agricultural settlements; and in the interior are a number of longitudinal lines now in operation that may be utilized as links in the great system proposed, or as valuable feeders for the support of an international highway.

There are now in operation in the Republic of Mexico nearly 8,000 miles of railway. There are five competing lines crossing the Rio Grande, and three furnishing transportation between the capital to the ports of the Gulf. The Mexican Southern has already reached as far south as the state of Oaxaca, and the new route across the Isthmus of Tehuantepec is rapidly approaching completion under the direction of Mr. E. L. Corthell, M. Am. Soc. C. E., a Chicago engineer whose skill and energy have done much to promote the prosperity and advance the commerce of our neighboring Republic. When this road is completed the Panama railway company will no longer dictate transportation rates between the two oceans, and the sailing distance between New York and San Francisco will be shortened 2,000 miles.

In the Central American republics, railway development has been slow, and most of the interior transportation is still carried on by carts and pack mules, but all of the chief cities are now connected by rail with the seaports, and existing lines are being gradually extended by both foreign and local enterprise. The present government of Guatemala has revived the plan of constructing a railway from the capital to the Atlantic coast, which was unfortunately abandoned after the death of President Barrios, eight years ago, and is now offering most liberal terms both in money and land grants to whomever will undertake the work. This project offers one of the most favorable opportunities for investment that can be found in all America.

Two important railway enterprises are being conducted by American companies in the Republic of Columbia. Mr. Cherry, of Milwaukee, is rapidly building a line from the Pacific port of Buenaventura into the Cauca Valley, which is the garden spot of that great Republic, and one of the richest sections in agricultural and mineral resources in all the world. It is the intention to extend this road to Bogota, thus giving the most populous and productive section of the country an outlet to the sea.

A Boston corporation, represented by Mr. S. B. McConnico, under a generous subsidy, and a concession otherwise favorable, is constructing a road from the ancient city of Cartagena, on the Atlantic coast, to the Magdalena River, which is the only thoroughfare for freight and passenger travel between Bogota and the rest of the world. Almost every ton of commerce the interior of Colombia has enjoyed since the conquest has passed up or down this stream, although its mouth is blockaded by sand bars which make the handling of freight difficult, dangerous and expensive. Years ago a canal was dug from the river to the harbor of Cartagena,

*A paper read before the Railway Commerce Congress at the World's Columbian Exposition.

one of the finest in the world, but failed to serve its purpose and has been partially abandoned. The railway, which is absolutely necessary to the progress and prosperity of the country, is progressing rapidly and will soon be completed, when the cost of transportation will be greatly lessened, and commerce facilitated to a degree that will revolutionize the trade of the Republic.

Venezuela has now 282 miles of railway in operation, and 1,240 miles either projected or under construction, extending from the northern sea coast to the interior of the country. The roads are being built by English and German capitalists under liberal subsidies from the government, and active work, which was suspended during the recent unfortunate revolution, has been resumed with energy.

There is a railway in Ecuador, which extends 56 miles from Guayaguil into the interior, and a contract has recently been concluded between the government and a syndicate of French capitalists for its extension to Quito, the capital.

Two years ago, what is known as the Peruvian corporation, composed of William R. Grace & Co., of New York, and a syndicate of English capitalists, assumed the entire foreign debt of Peru in consideration for the transfer to it by the government of all the railways in the Republic, and the control of certain mines which have been celebrated for centuries and furnished much of the riches of the country. The famous Oroya Railway, which was built by Henry Meiggs, has been extended across the Andes to Cerro de Pasco, the mines from which the Incas drew much of their treasure; and other lines are being built to important inland cities and mineral sections of the country. A party of engineers has recently sailed from New York to make a survey for the extension of the Oroya Railway to the head of navigation on the Amazon, which offers an enormous economical advantage in shipping the produce of the country to Europe and the United States over the present routes by way of the Straits of Magellan or the Isthmus of Panama. The increasing demand for rubber, and the destruction of the forests along the lower valley of the Amazon, which formerly furnished it, make it necessary to secure some means of transportation from the new sources of supply which have been found in the eastern provinces of Peru, Ecuador and Bolivia.

During the last year the great railway of Bolivia, which connects the port of Antofagasta, on the Pacific, with the mines of Huanchaca, 350 miles, has been extended 189 miles northeastward to Oruro, and gives the products of that Republic an outlet to the sea. Although this road, with a gage of 3½ ft., cost the enormous sum of $60,000,000, and crosses the three great ranges of the Andes, it is paying an annual dividend of 11%.

Railway progress in Chile has been rapid and profitable, and there are now in operation nearly 2,000 miles of road, mostly owned by the government. Nearly every town of importance is reached by railway, and there is a series of parallel lines across the narrow strip of territory that forms the republic from the northern boundary to the southernmost limit of population. The failure of the Baring Brothers seriously retarded work upon the road that is to connect Buenos Ayres with Valparaiso, and postponed its completion several years, but the contractors are at work again and it is expected that trains will cross the southern continent from ocean to ocean before the close of 1894. This road is one of the most daring and expensive undertakings of the age. Eight tunnels have been pierced through the backbone of the continent, their total length being 9¾ miles, and the cost of construction has been enormous. It is now but two days' journey on muleback between the termini, and the last tunnel is being driven.

The Argentine Republic and Uruguay have suffered severely from the consequences of excessive enterprise, but with good crops and economy the financial condition of both countries is being rapidly restored. In the Argentine Republic 7,676 miles of railway, which cost $346,000,000, are in operation. Uruguay has 1,000 miles, furnishing communication with the seaboard for all the principal cities and towns.

Brazil has 84 railways, aggregating about 7,000 miles, and the most of them are paying investments. The extension of several of the lines has been contemplated, but very little actual construction has been done during the last two or three years, because of political disturbances and financial depression.

Steel rails have been laid almost one-third of the distance between Buenos Ayres and Bogota, and through the most difficult and least attractive portion of the continent—the Gran Chaco of the Argentine Republic. The northern terminus of the Argentine system is at Jujuy, 993 miles from the capital. The distance from that point to La Paz, the capital of Bolivia, is 500 miles. From La Paz to Santa Rosa, Bolivia, a line has been constructed 220 miles in length; from Santa Rosa to Cuzco, Peru, the ancient capital of the Incas, the distance is 190 miles; from Cuzco to Santa Rosa, Ecuador, along the famous highway of the Incas, is 880 miles, and from there to Bogota it is 590 miles. It is therefore 3,373 miles from Buenos Ayres to Bogota, of which 1,213 is already constructed; leaving a gap of 2,160 miles to be filled.

The construction of an intercontinental railway was first publicly suggested by Mr. Hinton R. Helper, and it was largely due to his efforts that a conference of the American republics was called to discuss this, with several other topics.

The conference met, and, after due consideration, adopted a report, which recommended the appointment of a commission of delegates representing each of the American republics to superintend a survey to ascertain the best routes, the probable cost of construction and the amount of existing and prospective traffic, etc.

The commission met and organized, and early in the spring of 1891 sent three parties into the field, well equipped for the survey, and accompanied by topographers, geographers, geologists, mineralogists and other scientific men to make a thorough investigation of the regions to be traversed as well as to designate the route.

The first party, under the direction of Lieutenant Macomb, of the Army, commenced work in Guatemala, near the southern boundary of Mexico, to which surveys had already been made under the direction of the government of that republic, and continued eastward through the republics of Salvador and Nicaragua, into Costa Rica, where in April last they were compelled to abandon work, owing to the failure of Congress to make the necessary appropriations.

The second party, under the direction of Mr. W. F. Shunk, began their survey at Quito, Ecuador, about the same time, and proceeded northward, through the republic of Colombia to the city of Cartagena, on the north coast of South America. Owing to the condition of the climate, which was extremely unhealthful at that season of the year, the second party did not continue its line along the Isthmus of Panama, but was transferred to Costa Rica, where at San Jose, the capital, a survey was undertaken eastward which was continued along the isthmus into the republic of Colombia to Cartagena, where the line from the south was reached.

The third party, under the direction of Mr. J. Imbrie Miller, also commenced work at Quito, and proceeded southward through Ecuador, Peru and Bolivia, crossing the main tributaries of the Amazon, until they reached the terminus of the Arequipa, Puno & Cuzco Railway, when they also were instructed to return to the United States.

Thus the entire route from the southern boundary of Mexico to the interior of Bolivia has been surveyed, and a few months would have carried the line to the northern boundary of the Argentine Republic and the northern terminus of its railway system.

It was the intention of the commission to run a line from the interior of Peru eastward through the interior of Brazil to Rio de Janeiro and the other principal cities of that great republic; and also from Colombia eastward to the head of navigation on the Orinoco and the capital of Venezula, but that important work had to be abandoned for the present.

The cost of this road is, of course, a matter of speculation, but no more money will be needed than has already been wasted upon the Panama canal: $300,000,000, which, I believe, is the sum already expended upon that enterprise, will, at the rate of $50,000 a mile, construct 6,000 miles of road, and the distance to be covered is much less than that. Even at a cost of $75,000 a mile, $300,000,000 will build it.

SCREENS IN AIR-BRAKE PIPES.

In presenting the report of the committee on "Tests of Air-Brakes," at the recent convention of the Master Car Builders' Association, Mr. G. W. Rhodes called attention to the screens which prevent dirt and grit from reaching the delicate mechanism of the triple-valve. These screens gradually get corroded and clogged with dirt. The following is a condensed statement of the exhibits made by Mr. Rhodes:

Formerly the train pipe drain cup was packed all around the screen with small pieces of sponge. A drain cup was shown in which this sponge had become packed nearly solid with dirt and dust. When the quick-action brake was introduced, in order to avoid obstructions to the movement of the air in the train pipe, the sponge was removed, and either through neglect or through zeal in the pursuit of quick-action, the screens in some cases have also been omitted. The effect of this is that the dirt and dust is carried forward and collects in the small cup-shaped screens at the entrance to the triple. Nine samples were shown of these small triple screens, which had been removed from cars that had been in service only a few months with no screen on the drain cup. Every screen was more or less clogged with dust, pipe-scale and rust, and some of them were packed solid. In one case a lump of coal about ⅝-in. square was found in one of these screens. This shows the great importance of the screen at the entrance to the triple to keep dirt out of its delicate mechanism, yet in some cases triples have been sent out inadvertently without these screens and have been put in service in that condition. We quote further from the report as follows:

Let us however return to the consideration of the drain cup. We hope, through this exhibition of triple valve screens removed from triples not protected with drain-cup screens, we have succeeded in showing how important a part a properly screened drain cup plays in the successful working of a quick-action air brake. It must be borne in mind, however, that everything eventually wears out on a railroad, and the Master Car Builder who allows the screens in his drain cups to run without any inspection or attention must not expect any better results than is obtained from those that are allowed to run without any screens. Those of us who examine into this will find that the netting rusts and cuts out and filth accumulates in quantities that is almost beyond belief.

Exhibit 3 shows a collapsed condition into which screens get when they become gummed up and worn out. It also shows the fine condition the sponge gets into when by long service it is thoroughly mixed with rust, oil and dirt. All sponge should be removed at once from drain cup, not only for freight cars, but from passenger car drain cups.

Exhibit 4 shows two triple screens removed from triples that had drain cups originally fitted with horizontal screens without sponge, but the screens had become misplaced. Apparently the screens were too long and were bent when the piping was screwed up. They were in this bent and flattened condition when removed from the drain cups. Air and dirt passed by without going through the screen, the result being shown by the condition of the triple screen. They are packed solid with dirt and are as bad as those shown in exhibit 2. Exhibit 5 shows a screen still in position but which from some cause has collapsed and partly assumed an upward position and is rapidly getting coated over with rust and dirt. Exhibit 6 shows a method by which this collapsing of screens might be averted. It will be observed that this is accomplished by simply inserting a piece of coiled wire. The arrangement is not patented and any one may use it.

The tender, as you know, is not fitted with the quick-action brake. Up to the present time we believe there has been no attempt on the part of any of the brake companies to use screens in drain cups of tender brakes. The lower cavity is supposed to collect all passing dirt and water and this is intended to be removed by blowing off through the small pet cock. In practice we believe it will be found that the opening to the pet cock soon stops up, the cavity fills with mud and dirt and the drip cup is then of practically no value. Exhibit 6 shows one of these cups as removed from a tank of an engine on the C. B. & Q. R. R. The cock is gone and the hole plugged with dirt and the cup well filled with dust and dirt. That this dirt will work its way into the triple must be evident from the illustrations already cited.

To sum up we advise as follows:

1. Remove all sponge from drain cups.
2. See that screens in drain cups and in triples are properly maintained and of proper mesh.
3. Apply screens to all tender drain cups.

THE IRON AND STEEL TRADES IN GREAT BRITAIN AND EUROPE.*

At the present time, the iron and steel trades of this country are in a very depressed condition, and it is difficult to seen in what direction hope for improvement lies. The year 1892 was in many respects one of the very worst the iron and steel industries of Great Britain have ever known. The production of pig iron fell off 600,000 tons; the production of wrought iron and steel was also much under that of some previous years. The most serious falling off, however, was in steel rails; the exports in 1892 being not much over half of that of 1890, while the exports in 1890 were under those of previous years. The total falling away of exports of metals and machinery in 1892 as compared with 1891 amounted for Great Britain to over $35,000,000.

*Abstract of the address of Mr. Richards, President of the Iron and Steel Institute, at London, England.

A characteristic of the iron industry of the past year has been a great decrease in the quantity of pig iron made from English ores. The imports from Spain in 1892 amounted to 3,750,000 tons of iron ore, which is equal to a production of 1,800,000 tons of pig iron; in fact, 26% of the whole production of pig iron was made from imported ores. The important question arises, how long the hematite deposits of north Spain will be able to maintain their output. It is generally thought that the most valuable and extensive workings are being rapidly exhausted, and that some of the most productive mines are not likely to last more than a few years longer. At Bilbao, with the exception of the large mines owned by the Orcanera and Franco-Belge companies, there are no very extensive mines left to be worked. There is hope, however, that the period of exhaustion may be delayed for some time—it is said about ten years—through the process of calcining, which will enable the surface ore (the extent of which is yet unproved) to be used. Calcining kilns are already erected, and one large kiln turns out 1,500 tons or raw ore weekly. There are, it is said, large deposits of ore free from phosphorus in the south of Spain; but these want development, and do not seem to promise very highly.

During the twelve months ending December, 1892, the quantity of basic steel made in England was 406,839 tons, of which 108,056 tons were open-hearth. In Germany and Luxembourg, in 1892, 2,013,484 tons of steel were made from phosphoric ores, of which quantity 186,252 tons were basic open-hearth, the rest being basic Bessemer.

Returning to the question of blast furnace practice in England, it may be said that we have been obliged to be content with such outputs per furnace as the usual complement of men can fairly deal with; indeed, there has been no inducement to increase production, for the blast furnace power of the country is far in advance of the demand for pig iron, so that our attention has been more directed to economical working than to large yields. At Eston, in a plant erected in 1877, with a 50% ore, 1,000 tons of hot blast pig iron are produced per week with 19 cwt. of coke, in a furnace 72 ft. high, and 23 ft. diameter bosh. The total cost of labor per ton of pig iron was below 60 cts., including everything connected with the handling of all materials for the making and removal of the pig. The whole of the coke, ore and limestone, amounting to about 3,500 tons per week, was handled by the two men charging the blast furnace. At the Dowlais company's new works at Cardiff, a production of upward of 1,400 tons per week has been attained from the Rubio ore with less than 20 cwt. of coke per ton of pig, in a furnace 75 ft. high and 20 ft. at the bosh; 70% of the output being No. 1 quality. The cost of labor was about the same as at Eston.

This large production without increase in the labor charge had been made possible by the introduction of machinery to rapidly remove the pig iron from the beds and break it up. The apparatus consisted of quick-running, overhead, steam traveling cranes, which covered the whole surface of the pig beds. The breaker was fixed at the far end of the line of furnaces. It was important that the pigs should be molded at equal distances apart, and means were devised for insuring this, so that the three fixed hammers on the hydraulic rams might exactly suit the distances of three pigs. The beds, being thus molded, were cast in groups of 30 pigs, which were not meddled with until cool. The overhead crane then picked up the whole group of 30 pigs and ran with it at a high speed to the breaker, depositing it on a light four-wheeled carriage running down an incline toward the breaker, thus enabling the workmen to push forward easily the loaded carriage. On arrival, the whole group of pigs was drawn forward by a pawl of sufficient length of stroke to place the group of pigs under the hydraulic ram, which at one stroke broke three pigs, though only one at a time, the sow being broken by a second ram. The four pieces of broken pig slid down a strong shoot into a railway wagon, the detached sand falling between the bars forming the shoot. One machine could in this way readily deal with 4,000 tons of pig iron weekly, working from eight to ten hours per day. The total cost of these operations was 3 cts. per ton.

Referring to cold blast furnaces, he mentioned that the No. 1 furnace at Lowmoor was put in operation over a century ago, the output being about 80 tons a week, and its fuel consumption about four tons per ton of pig. It had recently been superseded by one which was probably the largest yet constructed. It was 70 ft. high; bosh, 18 ft. diameter; hearth, 9 ft.; throat, 15 ft.; bell, 11 ft.; capacity of furnace, 10,700 cu. ft. There were two calcining kilns, two single high-pressure non-condensing blast engines, and four Lancashire boilers. With one engine at work, making 28 revs. per minute, 4 lbs. pressure of blast, and 3 tuyeres with 4-in. nozzles, an output of 350 tons of gray iron per week was attained, the quantity of blast at atmospheric pressure being 10,000 cu. ft. per minute. The coke per ton of pig was 38 cwt.; and the raw ore contained 30% of iron, or about 42% when calcined; 3½ tons of raw ore were required to make a ton of pig iron. There was no doubt that a blast furnace, in order to work well and give a regular quantity of pig iron, should be worked at a fairly fast rate of driving; and it was also certain that the amount of iron produced depended upon the quantity and pressure of the blast driven in. The speed at which a furnace should be driven could only be determined by experiment, but the furnace in question worked far better when making 350 tons per week than it did when producing only 200 tons.

With regard to manufactured iron, the President remarked that the puddler was not yet dead, as was shown by the production last year of 1,500,000 tons of puddled bars. In speaking of best Yorkshire iron, he was only able to describe from personal knowledge the process of manufacture at Lowmoor, with which works he is connected, and where really cold-blast pig iron had always been exclusively made. It contained from 1 to 1¼% silicon and .3% of phosphorus. The whole of the pig iron was passed through the refining process, no pig iron being puddled. The refinery eliminated the whole of the silicon, and reduced the phosphorus to 0.1, by constant practice with materials of very slight variation, the refiner knowing how to leave the carbon untouched. The puddlers, therefore, had only to eliminate carbon and the small remaining phosphorus in order to obtain a practically pure lump of iron. The puddler worked ten heats of refined metal of 3 cwt. each per turn. The puddled balls were all worked under 50 cwt. steam hammers into slabs about 12 × 10 ins. of varying thickness. Those slabs were then piled and repiled to make the required weight for rolling into the various sizes of finished iron, whether plates or bars. All these weldings required the greatest care in heating and hammering; and the iron bore a very high heat without any deterioration of quality. In plate rolling, the greatest care, too, had to be taken to avoid laminations and blisters; the purer the iron, the more difficult it seemed to be to prevent them. Careful examination was made when rolling by having jets of water playing on the surface of the plates to detect blisters or unwelded portions. The inspection was continued when the plate was cold by rapping all over both surfaces with a hammer and noting the sheared edges all around the plates. The result of all this care, skill and good materials was a soft, ductile and reliable iron. The speaker then referred to some recent experiments made by Professor Arnold with wrought iron.

In dealing with Siemens-Martin furnaces and plate rolling, he mentioned that, whereas in 1880 there were 126 open-hearth melting furnaces, producing 251,000 tons of ingots a year, in 1890 the number had increased to 320, with an output of 1,564,200 tons, and in 1892 to 359, and was still increasing. The capacities of furnaces had been gradually raised until some had given as much as 40 tons of steel at a cast, but a more economical size for all-round work had a capacity of from 20 to 25 tons. The construction and form of the furnace itself is generally much as it was left by Sir Wm. Siemens. A valuable improvement was made by Mr. J. Riley, in conjunction with Mr. Dick, when he separated the regenerative chambers from the furnace; but the most successful advance was made a few years ago by the former in the general arrangement of handling and dealing with the molten metal till it was converted into a finished plate without reheating the ingot.

Treating of Bessemer converters and rail-rolling, he said that the largest production of ingots, 2,140,000 tons, was in 1889, and the largest output of rails, 1,235,785 tons, in 1882. Although there were 108 Bessemer converters in the country, only 1,510,810 tons of ingots and 535,836 tons of rails were made last year. The steel trade being in a more stagnant position this year than it was last year, there was no scope for the energy of the steelmakers, and they were unable to show any satisfactory results of output, or any great improvements in construction or arrangement of plant.

It was impossible with all the knowledge of blast furnace working to obtain a uniform quality of iron; ladles of iron taken direct from the blast furnace sometimes varied considerably, especially in the percentage of silicon. Captain Jones had, however, constructed a reservoir which was termed a "mixer," which would hold 100 tons of molten metal, with the view of equalizing the quality of the iron used by mixing iron from several furnaces and from several casts. Two of those mixers had been built at Eston, and had given greatly improved results. A description was then given of the latest improvements carried out in Bessemer steel-making at Scranton, Pa. In conclusion, the President stated that, so successful had we all been in economically increasing production, we had inundated and swamped the markets for the time being, and that at present, and for some time past, there had not been enough work for half the steel producing power of the country. New markets were looked for in vain, and no one seemed to be able to answer the question as to where the trade was to come from to keep the workmen employed and the works in operation. Many serious depressions had previously taken place, though none seemed so deep and prolonged as that at present. There was, however, left to the iron and steel trades that inestimable blessing—hope.

THE AUSTIN DAM ACCIDENT.

In our issue of June 8 we printed the first press dispatches from Austin, giving particulars of the break which occurred at the gatehouse at the east end of the dam, on May 30. As the Austin dam has attracted such general attention among engineers we give further space to the extracts below from the Austin daily papers. All those concerned in the work appear to agree that the cause of the break was a layer of loose material in the rock below the foundation of the headgate masonry. As the water was raised in the pond above the dam it found access to this seam and washing out the sand or clay which it contained, caused a settlement of the foundation. As to where the responsibility rests for the failure to discover and close this seam, our readers can form their own judgment, after making proper allowance for exaggerations and prejudices in the local newspaper reports. We may mention in this connection that an amusing feature of the affair is that so much anxiety seems to have been felt lest the water should escape so that the regatta which was to celebrate the completion of the dam could not take place, that the danger of heavy loss to the city by the destruction of expensive works seems to have been quite overshadowed:

Out at the dam this morning a large force of men were still at work on the cofferdam, but at 11 o'clock it was the opinion of all who had seen the rushing torrent yesterday that it had not been reduced. Mr. Frank Hamilton, who is directing the work and who was on the ground all of last night, and other gentlemen are confident, however, that they will succeed in completely checking the flow.

The caving in under the penstocks was very great last afternoon and night, and the water to-day was rushing through the wreck with terrific force, and it looked as if the entire support to the great pipes would give way and let them drop, in which event the pipes are likely to be very much damaged.

The figures given in "The Evening News" yesterday were obtained in the office of His Honor the Mayor, and they represented an estimate made by one of the Mayor's warmest friends and a great friend to the whole enterprise, who happened to be present. He based his estimate upon the present headgate and wheel pit work being a total loss, and there appears to be no doubt about this, and this work cost the city something over $61,000. He then thought from what he had seen and heard that to extend the work east into the bank to a place of safety, damage to pipes and other expenses would be at least $80,000, making $141,000, and he remarked, "Some think it will be $250,000 before everything is safe."

These figures, as stated, came from a warm personal friend of the Mayor and of the dam, and they were provoked by "The Evening News" reporter remarking that he (the reporter) thought the loss would be $40,000 or $50,000, and they were given in the presence and hearing of the secretary of the Board of Public Works.

The gentleman used the word "loss," and so did this paper. It probably would have been better to have said loss and extra expenses, as the rebuilding of the work damaged and extension of the masonry will be no loss, but extra expense.

Water in the lake this morning was something over a foot below the top of the dam, while that in the cofferdam crib was about a foot and a half below the level of the lake. Men were hard at work with a derrick this morning lifting pieces of pipe from the penstock pit to a place of safety.

The fall of water is so slow that the regatta will not be interfered with in the least. If the cofferdam is a success by to-morrow, the pipes on the west side can be closed and the water again be sent over the top of the dam by regatta day. Be this as it may, there will be plenty of water, and the regatta is all right.—Evening News, June 1.

An "Evening News" reporter last afternoon called on Mr. James Waterson, the contractor who built the headgate and other masonry damaged at the dam, and he quietly furnished some interesting information in a way that would convince most any one that he knew what he was talking about.

In short, Mr. Waterson is a practical man, evidently up in masonry, and familiar with its strength and resisting power. He stated that he had no plans of the work, but constructed according to his printed specifications under the direction of the engineer, his contract requiring everything to be decided by the engineer.

"Who drew up the plans and specifications?" asked the reporter.

"They were Mr. Fanning's," was the reply.

"Was any change made in them?"

"I don't know. I never had them; but my specifications were not carried out on some of the work. That wing wall running up stream, which first broke when the water first began to run through, was not constructed according to the specifications."

Mr. Waterson then explained just how the change was made, and while at it he called attention to other changes. He was also very emphatic in saying that a 4-ft. wall he constructed, and which has been swept away, should have been 8 ft. thick, and "that was the opinion of Mr. Werenskold, the engineer, and we often talked about it."

"Was the work extended into the bank as far as the plans called for?" was asked.

"I can't say. My specifications called for nine penstocks, and I only put in eight, as I was instructed to do. And I may say that, in my opinion and in that of Mr. Werenskold, the masonry between the penstocks is too narrow and light."

"Did you know of the existence of a cave just above the work?"

"Yes, we all knew of it. Messrs. McDonald and Groves took the rubbish out of it, but they never had it stopped up, nor were soundings made to see where it went, or if there were others."

"Are there others?"

"Well, I should say; I found the outlet of one along about the last day I worked."

Mr. Waterson then explained that while driving in a drill one day it dropped through, and so far as known, it is now keeping company with McGinty, for he has not laid eyes on it since.

Continuing, Mr. Waterson said: The cave just above the dam slopes down under the work to a depth of 32 ft. He stated that the weak point about the formation contained a stratum of blue clay, and that for masonry to be safe that stratum must be gotten rid of, or else something must be done to keep water from it. It was all right as long as water is kept from it, but it would be all wrong if water once entered. He had no idea how far this stratum extended into the bank.

"Under whose supervision did you work?"

"My specifications said the engineer, and he was Mr. Werenskold, a mighty good man, and he knew his business; but Mr. McDonald was constantly interfering, and some of the most foolish things were done I ever saw in work of so much importance. It bothered me, and I really didn't know what to do. Mr. Werenskold was bothered, too, and he wrote the Board of Public Works as to carrying out Mr. McDonald's orders, and I received this," and Mr. Waterson handed the reporter the following letter:

Board of Public Works, Nov. 9, 1892.

Mr. James Waterson:

Dear Sir: I am instructed to inform you that you must follow instructions of the Mayor with reference to excavation and the building of the power-house foundation, abutment wall and other work.

Respectfully, W. J. Oliphant, Secy.

Mr. Waterson said he was not surprised at the accident, and he stated that the whole of the work would have to be rebuilt. He was not expecting it quite so early, but he knew it was bound to come.

"It's very fortunate," he said, "it happened when it did, as the loss would have been so much greater had it happened after the whole work had been completed." Mr. Waterson also incidentally remarked that it was bad for the city when the change from a canal to penstocks was made, and engineers had expressed to him that the change was a bad one.

Engineer Frizell's plan called for a canal to take the water from the lake to the power-house, to be located about 1,000 ft. below the dam. He was, it is stated, providing for a contingency, and Mr. Waterson said yesterday it was a wise provision. All the engineers called to Austin say nowhere in the world has a river as long, as large and subject to as tremendous overflows been dammed. This fact, it is understood, led Mr. Frizell to doubt the propriety of using penstocks, with their necessarily weakened walls, to battle against the mighty force of water that they would have to contend against.

Mayor McDonald, however, insisted on penstocks, and when Engineer Fanning was called he drew up plans for penstocks to conform to the wishes of those in authority, and Mr. Waterson unhesitatingly says the change was a bad one. Nothing but the great and massive dam should resist the force of the Colorado, but if the city will have penstocks, they should be in masonry as powerful as the dam itself.

Engineer Werenskold was in town the day the water made its break for liberty, and left for Dallas night before last where he goes to test the pumps of the city water-works. While comparatively young, he has a brilliant reputation as an engineer, and his work here met with the most hearty approval of Engineer Fanning. In conversation he told about the same story as given by Mr. Waterson. Mr. McDonald's continual interference with the work, to its great injury, as he, Werenskold, thought, prompted him, for his own protection, to communicate with the Board of Public Works.

To the communication he received the following, which he carefully carries around in a safe wallet and pocket:

Board of Public Works,
Austin, Nov. 9, 1892.

Mr. W. Werenskold:

Dear Sir: The following action was had at a meeting of the Board of Public Works held Nov. 7, as appears in the minutes of said meeting:

"Mr. Hamilton moved that the secretary be directed to acknowledge the receipt of Engineer Werenskold's communication, dated Oct 15, 1892, and to notify him to follow instructions of the Mayor with reference to excavation and the building of the power house foundation, abutment and other work under the James Waterson contract, which motion prevailed." Respectfully, W. J. Oliphant, Secretary.

—"Evening News," June 3.

The morning after the accident of the leak "The Statesman" estimated the damages and cost of full repair at $35,000. That its estimate was fair and even liberal is borne out by Mr. Fanning's report to the board if public works. It is as follows:

Austin, June 10.

The Hon. Board of Public Works of Austin:

Gentlemen: In accordance with your request I have examined the break in the bank near the easteriy end of the headgates of your new dam. I find evidence that the stream of water flowing from the pond through the break had become quite large before it was stopped by a coffer dam, which extends from the easterly end of the main dam to the bank, at a point about 150 ft. above the easterly end of the headgates. The position of the coffer dam was well chosen for its purpose, and the coffer dam is now holding the water in the pond, while the river is flowing over the crest of the dam.

The crevice through which the water commenced to escape is in a stratum below that on which the headgate masonry rests. The direction of the crevice is not quite parallel with the river canyon, but diverts easterly about 30°, receding from the river, and passes easterly of the end of the headgates. On the down stream side of the headgates the crevice meets a seam in the rock nearly at right angles to it. This seam extends diagonally in the direction of the power-house.

In an early stage of the construction of your works an excavation was made for the head of the proposed canal and the location of the headgates. This excavation commenced about 100 ft. upstream from the site of the headgates and the end of the dam, and it forms a level bench 12 ft. lower than the crest of the dam. The extreme upper end of the excavation came very near to the crevice above described. The leak apparently commenced by water entering the crevice near the extreme upper end of the excavation, 80 or 90 ft. upstream from the headgates. The water then followed the crevice through a low stratum and enlarged the crevice, so that before the flow was stopped a long section of the east bank settled, and the easterly end of the headgate masonry settled with the bank. The flowing water was in the meantime escaping at the site of the power-house.

The easterly side of the crack made in the bank by the settlement is about 25 ft. easterly from the east end of the headgate masonry. The escaping water has evidently made a wide excavation in a low, soft stratum of the rock. The extent of the undercutting cannot be determined until a trench has been cut down into and across it. The coffer dam, if maintained, will permit the proper trenching for examination of the undercutting, and the same trenching will also be required for putting in a masonry wall for a cut-off across the crevice. This cut-off wall should extend from the return wall of the dam, easterly beyond the crevice and into the east bank as far as shall be found advisable, after examination of the material cut into. For the present, I desire to repeat the advice relating to this break given to your honorable board verbally on the day of my first inspection of the break, viz.: That the coffer dam be made broader at its inside toe and be carried up higher so as to protect the excavation against the ordinary flood flow of the river, say 8 ft. depth of water on the crest of the dam, and that this raising and strengthening of the coffer dam be done as expeditiously as possible, because the season has arrived when the probability of a flood is greater than at any other season; and also that the trenching for the examination of the scour in the crevice and strata of the rock be made at once, so that the suggested cut-off wall may be built at an early day, and I may remark that this cut-off wall will not be difficult to construct behind the coffer dam.

Advice as above was also given to the engineer in charge for his immediate guidance while awaiting your further instructions, and he has so far directed the work in accordance therewith.

J. T. Fanning, Consulting Engineer.

His plan, as accepted at the same time as his report, briefly stated, is as follows: He will take down three of the penstocks nearest the east end and reset them as before, only deeper, as they only have been injured. From the east end of these headgates he will run a wall, let in down to the bottom of the soft strata, as far east as required until it rests on solid rock. Then south of the penstocks, beginning at the east end of the bottom of the power-house foundation, he will run a wall all the way across behind the penstocks and around them, connecting with and making it the same as the wall extended east from the end of the headgates into the east bank. This wall will have a deep foundation like the granite return wall at the end of the dam that runs down to the power-house. This will be built up to a height of 8 ft. above the crest of the dam; and between it and the back of the headgate masonry the space will be filled in by stone and clay, the very best puddling material possible. The top of this over all the big pipes will be a solid earth surface. This wall will be absolutely water-tight. Its object is that should there be any soft strata of rocks under the other five penstocks, this wall and the filling in will be a complete preventive of these soft strata wearing through.

Upon being asked by the board as to the cost of all work, Mr. Fanning said he could not give accurate figures, but that for all the work already indicated and for repairing the granite foundation for the power-house and putting in a new foundation where the limestone bench had caved in, the total cost would be under $50,000.

The board, by resolution, then requested Mr. Fanning to draw up his instructions in writing as to the excavation and wall work and give them to Mr. E. W. Groves, the engineer in charge of the men.—"Austin Statesman," June 13.

THE RELATIVE MERITS OF COMPOUND AND SIMPLE LOCOMOTIVES.

As stated last week in our report of the Master Mechanics' Convention, the committee on compound locomotives made a very creditable showing for the compounds which are now at work in the United States. Records of expert tests have showed considerable variation, and both the advocates and the opponents of compound locomotives have tacitly agreed to let the monthly performance sheets tell the story whether the compound or the simple is the better engine. The increase in the use of compound locomotives during the past year has been remarkable. In June, 1892, there were 114 compound locomotives running in the United States. June, 1893, finds 422 in service, of which 316 are of the Vauclain four-cylinder type, built by the Baldwin Locomotive Works. There are also 188 compound locomotives now under construction and 75 compounds of American manufacture have been shipped to foreign countries. We may say here that these figures given above were evidently collected some time ago, as the Baldwin works alone have now over 400 compounds in service and are turning them out at the rate of about 25 per month. About 40% of the output of the Baldwin works at the present time are compounds.

Reports from over a dozen railways were presented by the committee, most of them giving results as shown by monthly performance sheets. Some of the roads had continued their comparative tests for over a year.

Table I. gives a summary of the results reported in freight service, and the following are the most important particulars of each test. The Northern Pacific tests were made on two Baldwin mogul engines of the same general dimensions, but the compound having 20 lbs. higher steam pressure. The engines had been in service two years and had run about 60,000 miles. During the five-months test they ran about 17,000 miles. It was stated that the compound gave some trouble by irregular wear of its crossheads.

Table I.—Comparative Fuel Economy of Compound and Simple Locomotives in Freight Service.

Road.	Duration of test.	Per cent. of coal saved by compound per Engine-mile.	Car-mile.	Ton-mile.	Per cent. of water saved
No. Pac.	5 mos.	20.3	...		
"	10 trips	....	...	22.2	11.3
Norfolk & So'n	2 mos.	21	22.2	...	...
N. Y., L. E. & W.	10 trips	15.1	8	3.85	4.12
Chic. & N. W.	6 mos.	7.7	....	....	...
Penn. & N. W.	9 mos.	18	....	....	....
C., M. & St. P.	11 mos.	9.5	....	-	....

The Norfolk & Southern tests were made on Baldwin mogul engines quite dissimilar in weight and age. The service was local freight and the average number of cars per train was 35.

The Erie tests covered 10 runs of 140 miles each. Both engines were new Baldwin ten-wheelers, and the compound had 25 lbs. higher boiler pressure. The service was quite dissimilar in that the compound was tested in December when the track was blocked with snow, and the simple engine in October. Thus, the simple hauled a train averaging 10% longer and 13% heavier than the compound on account of this difference in the weather. Boiler repairs on the compound promise to be much less than on the simple.

The Chicago & Northwestern figures are for five Schenectady simple engines compared with one Schenectady compound. All engines were new and were run first in, first out. Mileage made was 27,000 to 36,000 miles. Compound had 4-in. larger wheels and 20 lbs. higher steam pressure.

The Pennsylvania & Northwestern gave performance sheet records of 16 Baldwin consolidation engines, of which eight were compounds and eight simple engines. The engines were of the same design and general dimensions save that the com-

pounds had 9,000 lbs. more weight on the drivers and 45 lbs. higher steam pressure. The average monthly performance sheet record of each class of engine was as follows:

	Cars han'ld. Mil'ge.	Lo'ded.	Em'ty.	Cost per mile run, cts. Coal.	Mat'l.	Labor.	Total.
Simple	1,747.1	304	329	6.59	0.92	0.86	8.33
Comp'nd.	1,769.3	283	330	5.40	0.46	0.78	6.65

Thus, this extended service test showed an average coal saving on the compounds of 18%, and an average total saving in locomotive expenses of 20%.

The Chicago, Milwaukee & St. Paul record covered nine 10-wheel Baldwin simple engines compared with one Baldwin compound, of the same type and general dimensions, the same engine, in fact, on which the extensive tests reported last year were made. The compound was run for five months by a first-class engineer, and for six months by a very poor engineer. The following table shows the cost for four simple engines and the compound for a period of 15 months, including all repairs from the time engines were received from the builders until all received general shop repairs:

	Simple engine numbers. 821.	822.	825.	826.	Comp. engine 872.
Miles per ton coal.....	22.40	22.05	22.42	19.45	24.84
Miles pint valve oil....	53.56	47.52	52.65	46.09	39.52
Miles pint machine oil.	19.74	18.68	19.21	17.87	20.95
Repairs per mile, cts...	4.01	3.91	4.82	4.22	4.26

In Table II., which gives the principal results obtained in passenger service, the Chicago & Northwestern record is for a new Baldwin eight-wheel compound compared with a Schenectady eight-wheel simple, four years old. The engines were dissimilar in several respects.

Table II.—Comparative Fuel Economy of Compound and Simple Locomotives in Passenger Service.

Road.	Duration of test.	Per cent. of coal saved per— Engine-mile.	Car-mile.	Ton-mile.	Per cent. of water saved.
Chic. & N. W.....	.....	10	..	..	....
Kings Co. El.....	1 year	24	24	24	....
Cleve., Ak. & Col...	40,000 mls.	32	15	....	....
Norfolk & W'n.....	.....	....	20.4	13.4	16.3&8.6
Cin., N.O. & T. P....	1,000 mls.	33.7	45.5	35.2	28.7
C., B. & Q..... ...	.....	—25	....	....	.. ..

The Kings Co. Elevated record covers about 50,000 miles service, and compares several simple engines with one Rhode Island compound. The service is precisely the same for both classes. The compound had 2,000 lbs. more weight on drivers, slightly larger heating and grate surface, and 30 lbs. higher pressure.

The Cleveland, Akron & Columbus record is for two Baldwin eight-wheelers, identical save that one is simple and one compound and both run at same pressure. The average train of the compound was three cars, of the simple four cars.

The Norfolk & Western tests were made on a Baldwin ten-wheel compound and a Rogers ten-wheel simple engine, the two similar in design, but the compound having 35 lbs. higher pressure, and 5,000 lbs. more on drivers, which were 8 ins. larger. The compound was new and the simple two years old.

The Cincinnati, New Orleans & Texas Pacific tests were made on two new Baldwin ten-wheel compounds and one simple, three years old. The engines were similar, but the compound had about 5,000 lbs. more on drivers, 16.2% more heating surface and drivers 6 ins. larger. The compounds had about 2% heavier trains and hauled 3% more car-miles.

The Chicago, Burlington & Quincy tests were reported in our issue of March 16, 1893.

The following were the "conclusions" reached by the committee and submitted as its report:

1. The compound is suitable for a variable class of freight service.

2. Its range of economy in such service is fully as wide as that of the simple.

3. Its increased coal economy over the simple in the average freight service of the country will be found to lie between 10 and 15% when in good running condition and handled with intelligence.

4. A well designed compound should not be more difficult to keep in a serviceable condition than a simple; that is, its regularity of performance should not be less than the simple.

5. The 4-cylinder compound will cost more for valve oil than a simple.

6. The running repairs of a 4-cylinder compound will be somewhat more than for simple; for a 2-cylinder compound they should not be more; the final comparison for repairs is undetermined.

7. The net running cost of a compound will be less on many roads than of a simple, the figure depending upon the design, cost of fuel and other local conditions.

8. In passenger service the availability of the compound is undetermined.

9. Complicated designs of compounds are not likely to prove successful or economical. The prevailing forms of starting valves in use in this country are especially noted as being too complicated—certain valves employed abroad seem to have more commendable points.

10. Attention is called to the necessity of long time tests and averages of a considerable number of exactly similar engines of both types to properly establish the status of the question. In such tests the influence of higher pressure for either type should not be allowed to complicate the results, as the effect of the highest modern steam pressures on economy of the simple is undetermined.

In the discussion on this report Mr. G. R. Henderson, of the Norfolk & Western, gave some interesting figures bearing on the cost of repairs on compound locomotives, which has been one of the points on which there has been most disagreement. In the first place, on the four-cylinder compound it was conceded by Mr. Vauclain that repairs on the cylinders would be something like double what they would on a simple engine. Now, by keeping a five-months record the Norfolk & Western found that cylinder repairs on all the engines on the road, including repairs on piston rods, packing, valves, valve stems and steam chests, amounted to only 2¾% of the total repairs on engines. The company's report for 1892 showed a total cost per locomotive-mile for repairs of 6.36 cts. and for fuel of only 3.86 cts. Coal costs the company only 78 cts. per ton, so it would be difficult to find a field apparently more unpromising for the use of the compound. Nevertheless, Mr. Henderson computed a saving by its use as follows: Assuming fuel saving of compound at 10%, the saving per 100 miles' run equals 38 cts.; hence, if the cylinder repairs on the compound are double what they are on the simple, the extra cost of repairs per 100 miles will be 2½% of $6.36 = 17½ cts., leaving a net saving of 20½ cts. per 100 miles. Taking the average annual mileage at 60,000 miles, this indicates an annual saving of $123. The extra first cost of a compound locomotive is about $600, so the annual saving pays an income of about 20% on the investment. As a matter of fact the compound shows a much higher economy than 10% on the Norfolk & Western; in passenger service 13 to 20%, and in freight service 20% is saved. The firemen greatly prefer the compound locomotives, and consider it a "soft snap" to run with them.

Mr. Mackenzie said that in some eight months' experience with a Baldwin compound on the New York, Chicago & St. Louis the engine had made about 32,000 miles, and had shown an average saving in fuel of 18.44% over a simple engine. The simple engines cost on the average $.007 per mile for repairs, and the compound $.012. This was partly due, however, to the fact that for the first four months the engineer made a practice of using high pressure steam in the low pressure cylinder, and wore his tires very badly. Twice during the eight months the crossheads were taken down and relined. Repairs on the eccentrics and all parts of the valve motion are bound to be much less on the compound than on the simple engine, on account of the perfect balancing and small friction of the piston valve.

Mr. Forsyth said he wished to correct the general impression that the recent tests on the Chicago, Burlington & Quincy were unfavorable to compound engines as a class. The fact is they were only unfavorable to the compound for the special service in which it was tested, heavy, fast passenger service. There seems to be no doubt whatever that the compound can show a material fuel economy in freight service, and the C., B. & Q. is now building compound freight engines at its Aurora shops.

Other testimony as to the fuel economy of the compound showed that on the Fitchburg a Rhode Island compound is saving $2,000 worth of coal per annum in freight service, compared with a simple engine of the same capacity. On the Pike's Peak rack road, with its grades of 16 to 25%, the compound showed a fuel economy of 35%, compared with the simple locomotive, and used so much less steam that it could pass water stations where the simple engine had to stop, and it made the run to the top of the mountain in 95 minutes against 150 minutes for its competitor.

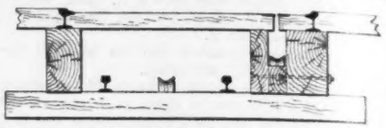


Fig. 1 Section of Conduit for Counterweights Ranier Ave. Electric Railway, Seattle, Wash.

It was the general testimony that the compound was a more powerful engine than the simple on up-grade work, through the ability to use high-pressure steam in the low-pressure cylinders in an emergency; also that flue repairs were materially less with the compound. The freedom from spark throwing of the compound is another feature of much importance.

THE COUNTERBALANCE SYSTEM OF OPERATNG ELECTRC CARS ON STEEP GRADES.

We illustrate in the accompanying cuts a device for operating electric cars on grades too steep to be overcome by the ordinary motor power, which seems from its simple and cheap construction to warrant more than passing attention from engineers engaged in such work. It frequently happens in locating an electric street railway line that there will be one or two places where for a short distance the street grades will necessitate a track grade too great to be easily overcome by the ordinary motor power without danger of injury to the mechanism, while the grades on the remainder of the line will be quite easy. At such places a simple device for furnishing additional power to overcome the grades can evidently be used to advantage. The device illustrated herewith is the invention of Mr. J. P. F. Kuhlmann, a civil and mechanical engineer of Seattle, Wash., and is the solution of the problem which confronted him in building the Ranier Ave. electric line down the steep hill to the water front on Washington St., in Seattle, Wash. Subsequently it was used with some improvements on the Front St. line, of the City & West Portland Park Motor Line, in Portland, Ore.

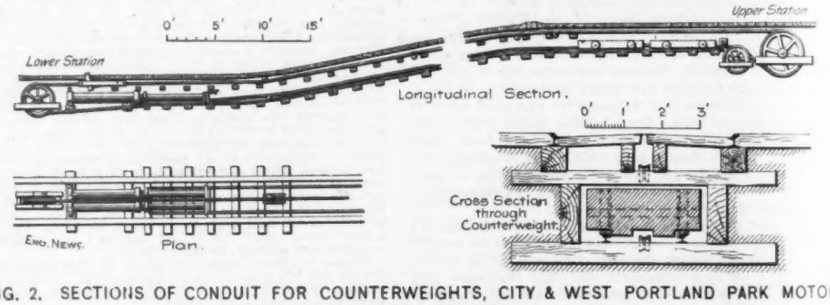


FIG. 2. SECTIONS OF CONDUIT FOR COUNTERWEIGHTS, CITY & WEST PORTLAND PARK MOTOR LINE, PORTLAND; ORE.

On the Washington St. line the grades between South Fifth St. and South Eighth St., for a distance of 1,000 ft., are 11%, 14% and 16%, respectively. Evidently the electric cars could not descend these grades safely with nothing more than the ordinary wheel brakes to restrain them, and unusually heavy motors would be needed to surmount them. A cable-road was obviously too expensive for such a short piece of line, so that some economical device had to be found to aid in the ascent and to check the descent. This plan devised was to operate a counterbalance weight running in a conduit underneath the track. This conduit was 3 ft. wide and 18 ins. deep, and is shown

in section in Fig. 1. In it two weights aggregating six tons run on a track. To one end of these weights is attached a ¾-in. wire rope and to the other a ⅝-in. rope, which runs in a smaller conduit on the inner side of the right-hand rail. Upon reaching the top of the grade on its way down the car picks up the dummy rope in the small conduit by being coupled to a bar projecting about 8 ins. from the ground, and in descending hauls up the weights, thereby checking its speed so that the wheel brakes will hold it if necessary. A car going up the hill is coupled in the same manner, and by means of the electric power starts the weights from the level at the top, which in descending aid in pulling the car up the grade. When the weights reach the foot of the grade and are released, any shock is avoided by means of a pneumatic buffer composed of 8-in. wrought iron pipes, in which 7-in. pistons work. On starting up the hill the weights pull out the pistons by means of a finger which is released automatically. Similar buffers are situated at the top of the grade. It may be stated that the weights exactly balance an empty car, and the motor has to overcome the weight of the load only.

The line as thus constructed was put in operation on Aug. 28, 1891, and has worked with uniform success since. In the Front St. line of the City & West Portland Park Motor Co.'s line, in Portland, Ore., however, the system has been improved in many particulars. The details of the mechanism at the upper and lower landings of this line are shown in Fig. 2. This line runs up Front St. for a distance of 550 ft. from the Southern Pacific R. R., crossing to Thomas St., on a grade of from 12% to 14%, and the need of some device for quickly stopping the cars is enhanced by the fact that the railway crossing is on a curve on a bridge just as the road leaves a side hill cut, making it impossible to see the trains coming.

For this line the main conduit was made the full width of the track, 42 ins. wide, and 14 ins. deep, with the smaller conduit, 6 ins. wide and 8 ins. deep, in which the dummy rope runs, directly above it. This arrangement may be seen from the section, Fig. 2. The principal improvement is in the coupling device which is inserted in the guard at the lower end of the car. The car on arriving at the lower end of the grade is stopped about 4 ft. above the point where the coupling tongue is located. This tongue, which forms the connection with the cable, is then raised above the slot by a lever located at one side of the track. The car is then allowed to run backward by gravity and to couple itself automatically. The current is then applied starting the car, and, through the tail ropes, the weights at the upper end of the grade. When the car arrives at the upper end, the conductor pulls a cord which disengages the tongue and it proceeds on its journey without stopping. On the down trip the tongue, which projects from the slot and is protected by a swelling in the roadbed, connects automatically with the car, making it impossible for it to descend the grade without pulling up the weights. At the lower end the conductor steps off the car and by raising the lever diconnects the car from the tongue. This coupling device requires the car to stop but once on the round trip, but it has to slacken speed for all connections and disconnections. On the Seattle line the coupling consists of a forked drawbar, in which the tongue attached to the dummy or the weights is fastened by a pin. This line also has safety brakes connecting the weights which act instantly in case the rope breaks, but these are dispensed with at Portland as unnecessary, and so also are the pneumatic buffers at the upper end, as the connecting tongue is so arranged that the weights cannot move after the car disconnects. The weights on this line are 6½ tons.

Mr. Kuhlmann states that he has carried as many as 95 passengers at a speed of seven miles an hour on the Portland line, and that twice a day a freight trailer is attached to the motor and is moved with ease. A fuse rarely blows out, and then only when the voltage falls low on account of insufficient feed wires. He is satisfied by experiments that if the counterweight is made 25% heavier than the empty car, a grade of 20% may be overcome and 75 passengers carried with the same motors and at the same speed. Two weights are used to follow the change in grades more easily, and when small single truck cars are run only one need be used, the other being left at the upper end of the grade.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

BALTIMORE & DRUM POINT.—Frank R. Biedler, Baltimore, who is managing the affairs of this road, is reported as stating that negotiations are pending for selling the road and that engineers have been sent over the route to examine it and to report to the prospective purchasers.

CHICAGO, INDIANA & EASTERN.—The Schafer, Nichols, Watkins Co., Louisville, Ky., has been awarded the contract for this road between Fairmount and Muncie, Ind., a distance of 26½ miles.

LOWELL, LAWRENCE & HAVERHILL.—The contract for constructing this railway, about 20 miles in length, has been awarded to Soule, Dillingham & Co., and work has been commenced at Lawrence, Mass.

MONCTON & BUCTOUCHE.—It is reported that a syndicate of American capitalists is planning to purchase this road, which is to be sold in August, construct an iron bridge over the Buctouche River, place a steam ferry between Richibucto and West Cape, and build harbor works at West Cape and a branch road from there to the main line of the Prince Edward Island R. R.

POUGHKEEPSIE & NEW HAMBURG.—Preliminary surveys for this railway, 12 miles in length, have been made by Lawlor & House, Poughkeepsie, N. Y.

UNADILLA VALLEY.—Work on this road, in New York, is reported as progressing rapidly. A construction train will soon be put on and the road ballasted from Bridgewater to Leonardsville.

WESTERN MARYLAND.—A correspondent writes us that on the extension from Porter's Station, on the Baltimore & Harrisburg Division, to York, Pa., the track has reached the western limits of the city of York, Pa. The total distance, under the present contract, is 15 miles. Of this the track was laid on 3.62 miles during 1892, and up to June 1, 1893, on 7.86 miles additional. Ballast gangs are following the tracklaying as rapidly as possible, about 6.5 miles being completed. The principal stations are Porter's Station, Spring Grove, Nashville, Thomasville and York, all in York county, Pa.

Projects and Surveys.

NEW CUMBERLAND & PITTSBURG.—Incorporated in Pennsylvania to build a road 16 miles long from near the south bank of the Ohio River from the extension of the New Cumberland branch of the Pittsburg, Cincinnati, Chicago & St. Louis through the townships of Greene, Racoon and Moon, Beaver Co., to the Pittsburg & Lake Erie at or near Phillipsburg; capital stock, $400,000; directors, John E. Davidson, Pres.; Jas. McCrea, J. J. Brooks, Wm. Mullins, A. McElvey and I. C. Scott, Pittsburg.

RARITAN NORTH SHORE.—Incorporated in New Jersey to construct a railway from Perth Amboy to Woodbridge, N. J.; capital stock, $50,000.

Southern.—Existing Roads.

ALLEGHANY IRON CO.—This company, of Iron Gate, Va., has nearly completed a railway 3½ miles in length, 3-ft. gage, extending from the Grace mines to the Craig Valley branch of the Chesapeake & Ohio.

HODGENSVILLE & ELIZABETHTOWN.—According to press reports, the right of way is being secured for the extension of this road from Hodgensville, Ky., its present terminus, to Scottsville, Ky., where it will connect with the Cumberland & Ohio, a road of 30 miles in length from that place to Gallatin, Tenn. From there the road will be built into Nashville. C. P. Huntington, of the Newport News system, is stated to be behind the scheme. It will form a connecting link between his smaller roads and give his system an entrance into Nashville, which he has long desired. This line parallels the Louisville & Nashville from Louisville to Nashville, and is about 25 miles shorter than that road.

WEST VIRGINIA, PINEVILLE & TENNESSEE.—Jas. F. Parr, Pineville, Ky., has been appointed chief engineer of this road. The present object of the road is to open up the timber and coal lands of the Southern Land Imprvt. Co. About one mile is nearly completed and surveys are being made for further work.

Projects and Surveys.

DAUPHIN ISLAND & MOSS POINT R. R.—This company has been organized at Mobile, Ala., to build a road from Dauphin Island through the state of Mississippi; Pres., J. B. Lyons, Chicago; Secy., John Cothran, Mobile.

Northwest—Existing Roads.

DULUTH, MESABI & NORTHERN.—The construction of this road to the Lake Superior mines in Minnesota, 18 miles, is nearly completed. Wolf & King, Duluth, the contractors, have about 700 men at work and 16 miles of track laid. Five miles of the road will be double tracked and have 80-lb. rails; 60-lb. rails being used elsewhere.

MASON CITY & FORT DODGE.—It is reported that Hamilton Browne, Pres. Boone Valley R. R., and director of this road, is planning to extend the road in Iowa south from Lehigh to Council Bluffs, and north to Manly.

SIOUX FALLS, YANKTON & SOUTHWESTERN.—Work on this railway between Sioux Falls and Yankton, S. Dak., is progressing rapidly, and it is expected that trains will be running by Aug. 15.

Southwest.—Existing Roads.

GREENFIELD & NORTHERN.—Surveys are being made for an extension of this road from Greenfield, Mo., to Cedar county, Mo., and it is stated that the road will be built at once. T. A. Miller, Gen. Man., Aurora, Mo.

TEXAS CENTRAL.—Surveys are being made to extend this railway in Texas from Albany to Lubbock, Tex. The citizens of Lubbock have appointed committees to secure the early construction of the road.

VELASCO TERMINAL.—It is reported that this company will ask for an amendment to its charter permitting a branch line from Angleton to Aloin, Tex., about 20 miles in length.

Projects and Surveys.

KANSAS CITY & ATLANTIC.—Incorporated in Missouri to construct a railway 200 miles in length from the town of Calnesville, Harrison county, to the Chicago, Kansas City & Texas, near the town of Smithville, in Clay county, and thence to Jackson county, near Kansas City. The counties to be traversed by the road are Schuyler, Putnam, Sullivan, Grundy, Davis, Harrison, DeKalb, Clinton, Clay and Jackson. Capital stock, $8,000,000; directors, Francis Armory, L. M. Crosby, E. W. Burdett, Boston; W. T. Burns, Baltimore; W. S. Wolcott, New York; T. A. Burness, Connecticut; J. J. Harrison, Dover, N. H.; A. C. Paine, Portland, Me.; Stephen Solmsby, Worcester, Mass.; Thos. C. Bates, Walton Holmes, Thos. R. Morrow, Kansas City, Mo.

KANSAS, OKLAHOMA CENTRAL & SOUTHWESTERN.—Organized in Arkansas City, Kan., to construct a railway from Stevenson, on the Missouri, Kansas & Texas, in Cherokee Nation, across the Osage and Pawnee reservations, through the counties of Payne, Logan, Oklahoma and Canadian, in Oklahoma, and thence through the Wichita, Kiowa, Comanche and Apache reservations to Vernon, Tex. The persons named as interested include the following: Judge Robert Martin, Guthrie, Okla.; J. R. Clark, R. A. Lowry, Stillwater; C. L. Severy, El Reno; W. H. Conner, Osage; S. M. Porter, R. C. Hollingsworth, Caney; V. C. Prasure, Coffeyville, Kan.

Rocky Mt. and Pacific.—Existing Roads.

ASTORIA & SOUTH COAST.—This road has been sold, according to press reports, to the Seashore Ry. Co., of Astoria, Ore., for $130,000.

BURLINGTON & MISSOURI RIVER.—It is reported that 350 teams and over 1,000 men have left Sheridan,

ELEMENTS OF WEATHER IN THE UNITED STATES OF MOST INTEREST TO ENGINEERS FOR THE MONTH OF MAY, 1893.

[Furnished to Engineering News by the Department of Agriculture.]

	Stations	Temperature. (Deg. Fahr.) Average	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average	Max.	Direction at time of max. velocity.	Precipitation—rain and melted snow—inches. Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	52.6	89	28	61	9.1	44	SW	3.97	1.35	18
	Portland, Me.	52.1	83	37	46	8.6	43	E	7.59	3.00	14
	New York, N. Y.	59.0	86	42	44	11.4	45	NE	5.16	3.04	11
	Pittsburg, Pa.	59.6	85	38	47	7.2	33	NW	4.50	1.28	18
	Chicago, Ill.	52.4	83	37	46	18.8	50	S	1.93	0.91	10
	Omaha, Neb.	59.0	86	36	50	8.6	36	NE	3.84	1.66	8
	St. Paul, Minn.	53.8	79	32	47	7.5	38	NE	2.66	0.98	11
	Duluth, Minn.	47.0	73	32	41	5.4	30	W	2.31	1.17	11
	Bismarck, N. Dak.	51.8	92	29	63	11.6	60	NW	1.26	0.48	10
	Average	54.1	84.0	34.6	49.4	9.8	42.1		3.68	1.54	12
Southern Cities.	Washington, D. C.	61.6	89	40	49	6.9	34	NW	5.41	2.73	14
	Louisville, Ky.	63.3	88	43	45	8.4	42	SW	4.19	1.56	13
	St. Louis, Mo.	64.0	89	43	46	12.2	50	SW	5.42	3.26	8
	Savannah, Ga.	72.6	92	54	38	9.6	34	W	2.22	0.57	14
	Leavenworth, Kan.	61.1	87	37	50	10.2	45	NW	5.82	2.73	9
	Jacksonville, Fla.	75.3	93	57	36	8.4	38	SW	4.18	2.00	11
	Chattanooga, Tenn.	66.8	92	46	46	5.6	26	NW	8.35	2.52	14
	New Orleans, La.	75.8	90	60	30	8.9	36	S	2.66	1.04	7
	Memphis, Tenn.	68 8	90	52	38	7.1	37	SE	13.34	4.27	12
	Palestine, Tex.	72.1	92	48	44	6.4	36	W	4.96	2.00	12
	Average	68.1	90.2	48.0	42.2	8.4	37.8		5 66	2.27	11
Western Cities.	Helena, Mont.	51.2	87	32	55	9.5	48	SW	3.04	1.50	13
	Port Angeles, Wash.	49 2	65	39	26	6.3	34	SW	1.85	0.52	13
	San Francisco, Cal.	55.8	74	46	28	12.2	38	SW	0.15	0.14	2
	Salt Lake City, Utah.	55.1	86	34	52	7 7	51	NW	1.68	0.80	9
	Denver, Colo.	51.3	87	28	59	8.7	56	NW	3.09	1.41	9
	Yuma, Ariz.	76.2	104	52	52	7.7	34	W	0.29	0.29	2
	Santa Fé, N. Mex.	55.3	77	31	46	8.5	51	SW	0.98	0.79	7
	Average	56.7	82.9	37.4	45.4	8.7	44.6		1.58	0.77	8

Wyo., within a few weeks to work on the extension of this road and that graders are at work from Tongue River to the Montana state line.

COLORADO MIDLAND.—Work on the branch of this road from Divide to Cripple Creek, Colo., is at a standstill. The road has been graded and rails distributed to Midland, a distance of eight miles.

NELSON & FORT SHEPPARD.—E. J. Roberts, Ch. Engr., is reported as stating that this road will be completed by October. It is the extension of the Spokane Falls & Northern road from the international boundary line to Nelson, B. C., 60 miles. The grade is 80 ft. to the mile from the Columbia River to the summit of Cottonwood Smith Lake and from there to Five-mile Point it is 130 ft. to the mile. About 500 men are at work near Fort Sheppard and as many more waiting to go to work. Grading has also been commenced at the Nelson end.

PECOS VALLEY.—The proposed line of this road from Eddy to Roswell, in N. Mex., has been permanently located. Murray Harris, Ch. Engr., Eddy, N. Mex.

SOUTHERN PACIFIC.—Reports from San Luis Obispo state that depot buildings, including roundhouse and machine works, will soon be built at that place to cost $100,000. The tunnel through the Santa Lucia is now in 1,950 ft., leaving 19.30 ft. yet untunneled, and is progressing 10 ft. per day. The road will be completed to this place by March and to Ellwood as soon as possible. The cost of the 120 miles from Santa Margarita to Ellwood is estimated at $6,000,000.

Projects and Surveys.

DENVER, SALT LAKE & SAN FRANCISCO.—The Denver chamber of commerce has decided unanimously in favor of the construction of this proposed road and has approved articles of incorporation for the company. The grade for the greater part of the distance is not expected to exceed 1% and the curvature will be less than 16°, after passing beyond Denver 50 miles. A five-mile tunnel will be required through the main divide, but one contractor is reported to have offered to construct this for $800,000 and another contractor for $80 per ft., or less. About 160 miles of the route have been surveyed. Thet capital stock is placed at $10,000,000, and the proposed directors includ W. N. Byers, H. M. Porter, Geo. Tritch, J. S. Brown and C. B. Kountze.

FLORENCE & CRIPPLE CREEK.—Incorporated in Colorado by Wm. E. Johnson, Eben Smith, Geo. E. Ross-Lewin, A. B. Roeder and Jas. McCandless to construct a railway between Florence and Cripple Creek, Colorado; capital stock, $1,000,000; principal office, Denver. The road will be built by the Florence & Cripple Creek R. R. & Reduction Works Const. Co., incorporated by Wm. E. Johnson, A. B. Roeder and Eben Smith; capital stock, $900,000. It is reported that grading contracts will be let at once.

SEATTLE & NORTHEASTERN.—Engineers are definitely locating the line for this proposed road from Seattle to connect with the Great Northern at Ballard, 60 miles distant. The instructions are to locate the line with a grade of 50 ft. to the mile. John L. Leary and Thos. Burke, Seattle, were the incorporator of the company.

Foreign.

MEXICAN NORTHERN PACIFIC.—This road has been graded and bridges built from Deming, N. Mex., the northern terminus, about 80 miles south into the state of Chihuahua, Mex. Over 130,000 ties have been delivered at Deming and the rails have been ordered from England. Huss, Townsend & Co., Chicago, are the contractors.

STREET RAILWAYS.

FALL RIVER, MASS.—The Fall River & Taunton St. Ry. Co. has been incorporated by Milton Reed, A. F. Dow, W. R. Warren and others to construct a street railway in Fall River, Taunton, Somerset and Dighton; capital stock, $350,000.

MALDEN, MASS.—The Malden, Melrose & Stoneham St. Ry. Co. has been incorporated by Geo. F. Butterfield, J. F. Berry, F. L. Whittier and others to construct a street railway in the places named; capital stock, $125,000.

NEWTON, MASS.—The Newton & Boston St. Ry. Co. has been authorized to increase its capital stock to $250,000 for extensions.

PAWTUCKET, R. I.—The Pawtucket St. Ry. Co. has been granted an exclusive franchise for 20 years of such streets as it already occupies. The road will be changed to standard gage, it is reported, and extensions made.

HARTFORD, CONN.—The committee has reported in favor of a charter for the Hartford, Manchester & Rockville Tramway Co., to build a street railway from Burnside Ave., East Hartford, through Manchester, to a junction with the Rockville & Ellington St. Ry. Co., Rockville; capital stock, $200,000; M. S. Chapman, N. T. Pulsifer, A. D. Claflin and others.——The senate has passed resolutions granting charters to the Rockville, Stafford & Southbridge Tramway Co., to construct a tramway in the towns of Stafford, Ellington, Tolland and Vernon; E. C. Phinney, R. S. Hicks, C. H. King and others. Enfield & Somers Tramway Co.; capital stock, $50,000; A. C. Matthewson, F. E. Hunter, H. C. Douglass and others. Enfield & Longmeadow Electric Ry. Co.; capital stock, $30,000; Chas. H. Briscoe, of Thomsonville; J. L. Houston, J. W. Johnson, J. W. Allen and others; to construct an electric railway from Warehouse Point, connecting there with the Hartford line, through Windsor Locks and Thompsonville to Longmeadow, Mass., where it would connect with an extension of the Springfield St. Ry., connecting Hartford and Springfield by an electric road. The route has been nearly all surveyed.

WATERBURY, CONN.—The road commissioners have recommended that the Waterbury Traction Co. be granted permission to change the motive power to electricity.

BROOKLYN, N. Y.—The mayor has signed resolutions granting franchises covering about 30 miles of streets to the Brooklyn City, the Nassau Electric and the Kings County Electric companies, and refusing the offer of the Union St. Ry. Co. of $257,000 for the greater portions of the routes for which the franchises were granted. The franchises were given in consideration of the payment of a percentage on the gross receipts of travel on each mile of the road, 1% on $20,000, 2% on $30,000 and 3% on $40,000.

CARTHAGE, N. Y.—The right of way is being secured for an electric railway to Copenhagen. A. L. Clark is interested.

MOUNT VERNON, N. Y.—The council committee has recommended that a franchise be granted to the Mount Vernon & Eastchester Ry. Co., electric motive power to be used.

SYRACUSE, N. Y.—The Syracuse, Fayetteville & Manlius R. R. has been organized to build an electric railway between the places named; capital stock, $250,000; Pres., R. R. Spaulding; Gen. Man., E. W. Emmons; Treas., C. B. Freeman.

CAMDEN, N. J.—The Camden Horse Ry. Co. has been granted authority to use electricity for motive power.

BRADFORD, PA.—An electric street railway franchise has passed the councils, and, it is reported, will be signed by the mayor.

EASTON, PA.—The Easton & Bangor Electric Ry. Co. has been incorporated to build a railway 16 miles long; capital stock, $100,000; Pres., J. M. Young, Easton.

MAHANOY CITY, PA.—The franchise for an electric railway on Main and other streets has been granted to the Shenandoah & Mahanoy City Electric Ry. Co. by a vote of 8 to 7. Several companies applied for the franchise. The company will commence the construction within 30 days and will have the road completed from Shenandoah to Mahanoy City, and from Delano to Mahanoy City by Dec. 1. Flat rails will be used.

MECHANICSBURG, PA.—Franchises have been granted to the Susquehanna and Harrisburg & Mechanicsburg electric railway companies, the roads to be in operation within 15 months.

PHILADELPHIA, PA.—The Philadelphia Traction Co. has voted to increase its capital stock from $7,000,000 to $9,000,000 to meet the expense of changing the motive power to electricity.

PHILLIPSBURG, PA.—The Phillipsburg & Houtzdale Passenger Ry. Co. has been incorporated by J. J. Patterson, W. E. Wallace and others to construct an electric railway 50 miles long through the coal regions of Clearfield county. The route has been nearly all surveyed.

YORK, PA.—The York & Dallastown Electric Ry. Co. has been incorporated by Wm. H. Laniers, John W. Steacy, L. A. Marshall and others; capital stock, $60,000.——The York County Electric R. R. has been organized; Pres., A. F. Geesey; Treas., C. C. Frick. Both companies propose electric railways between this city and Dallastown. The first named company has voted to employ an engineer to survey the route and prepare estimates for the construction.

AKRON, O.—The city clerk has been instructed to advertise for bids for a street railway in North Main and Furnace streets.

FREMONT, O.—Henry T. Heller, Tiffin, has petitioned the Sandusky county commissioners for a franchise for an electric railway from this city to Clyde and from thence to Green Springs.

PAINESVILLE, O.—The Painesville, Fairport & Richmond St. Ry. Co. has petitioned for a franchise.

SPRINGFIELD, O.—The council has granted a franchise to the Dayton Traction Co. It is reported that the company will build an electric railway from Harshmansville through Dayton to Miamisburg, a distance of 15 miles, and that the road will eventually become part of an electric system extending from Cincinnati to this city.

TOLEDO, O.—J. P. Brown was recently awarded a francise for an electric road into Maumee, and is reported as stating that he will soon commence the construction of a road to connect the two cities.

YELLOW SPRINGS, O.—Wayne Neff, Cincinnati, has been securing the right of way through this town for an electric railway which will run from Springfield to Xenia. It is reported that the power house and dynamos will be located here, and that the 18 miles of road will cost about $300,000.

GREENCASTLE, IND.—The Greencastle St. Ry Co., noted last week as incorporated, has been granted a 50-year franchise for an electric railway, with authority to put in a light, heat and power plant after the railway has been constructed. J. W. Welk and F. G. Gilmore are among the incorporators.

MUNCIE, IND.—The city council has passed an ordinance making it a finable offense to propel a street car by steam power. The Muncie St. Ry. Co. has been using dummies for three years and refuses to change the motive power.

NOBLESVILLE, IND.—The Chicago & Central Indiana Electric Ry. Co. is reported as about to contract for railway material. Address E. J. Pennington. The plans of the company, according to reports, are as follows: The line between Indianapolis and Noblesville will be a double track, and the double track will be extended to Chicago, through Sheridan, Frankfort and Lafayette. A single track will be laid to Kokomo, through Tipton, and at Kokomo there will be extensions to Logansport and Peru. Another branch from Noblesville will lead to Fort Wayne, through Elwood and Marion, while a fourth will go to Muncie, through Anderson.

CHICAGO, ILL.—The Chicago & Central Indiana Ry. Co. has been incorporated by Geo. A. W. Kniz, N. D. Pontius and Geo. S. Foster; capital stock, $5,700,000.

PEORIA, ILL.—The South Peoria Electric Ry. Co. has been organized to construct a road in South Peoria.

FREMONT, NEB.—The City St. Ry. Co. has been incorporated with a paid up capital of $45,000.

ST. LOUIS, MO.—Surveys have been completed for an extension of the Midland Electric Ry., 10 miles in length.

WACO, TEX.—The Hobson St. Ry. & Light Co. will issue bonds for $250,000 for improvements and extensions.

MANITOU, COLO.—M. A. Leddy has been granted a franchise for an electric railway estimated to cost $50,000. The road must be completed within two years.

MODESTO, CAL.—J. W. Dunlap and J. W. Woodside, Oakdale, have applied for a franchise for an electric railway which is proposed to run from San Joaquin River through this city to Sonora, a distance of 60 miles. A dam 75 ft. high is included in the scheme.

HIGHWAYS.

PENNSYLVANIA.—The Cambria Iron Co. has had surveys made for a new road from Water St. in Kernville to Westmont.

INDIANA.—Ansel B. Smith, Engr. and Supt., will receive bids at the auditor's office, Marion, until July 3 for the construction of the Rhea free gravel road; total length, 5,300 ft.; estimated cost, about $2,000. A special election will be held in Owen county to vote on the construction of a macadamized road from Spencer to Paricksburg, a distance of 12 miles.

CALIFORNIA.—The supervisors of Humboldt county will receive bids at Eureka until July 11 for constructing certain roads.

BRIDGES.

WINDSOR, ONT.—Plans are being prepared for a new iron bridge over the Michigan Central R. R. tracks to cost $15,000.

CALAIS, ME.—The city government has voted to build a new free bridge across the St. Croix River to cost $40,000.

CONCORD, N. H.—The city government has voted to construct a new free bridge over the Merrimac River to cost $17,000.

MIDDLETOWN, CONN.—The Middletown & Portland Bridge Co. has been chartered with a capital stock of $100,000 to build a bridge across the Connecticut River.

NEW YORK, N. Y.—Bids are asked until July 11 for building a temporary bridge and approaches over the Harlem ship canal, east of the Kingsbridge road, and removing obstructions from the ship canal necessary to build the new bridge over the Harlem ship canal on line of Kingsbridge road.

CINCINNATI, O.—The Hamilton Co. Commissioners will receive bids until July 12 for building an iron bridge over Blue Rock Creek. John Hagerty, Co. Aud.

COLUMBUS, O.—Bids will be received until July 24 by Henry J. Curen, Co. Aud., for furnishing material and doing the work necessary to build the substructure of a bridge over a run north of Spring Hill, Pleasant township, estimated quantities being as follows: For 150.36 perch of sandstone masonry; 178.64 limestone masonry, relaid; 200 cu. yds. dry excavation; 150 cu. yds. wet excavation; 100 cu. yds. fill; 25 perch of riprap; 35 perch of concrete; constructing temporary roadway; 10 cu. yds. of gravel.

OAKLAND, CAL.—The engineers of the Southern Pacific Co. are preparing plans for a new swing bridge to replace the present bridge over the estuary at the foot of Harrison St. It is stated that it will have a swing span of 500 ft., and provide for two carriage ways in addition to the railway tracks.

TACOMA, WASH.—Plans and specifications for the new bridge are now being prepared by Cy. Engr. Jas. M. Morrison. The bridge will be built from Eleventh St. across the tide flats, and bids will soon be called for. The west approach to the bridge will be 240 ft. There will be two short spans of 60 ft. over the railway tracks. The proposed channel will be 600 ft., and will be crossed by an iron and steel structure consisting of two fixed spans of about 185 ft. each. There will also be a draw span 250 ft. in length. The east approach to the bridge will be on a pile trestle.

WATER-WORKS.

HANOVER, N. H.—Bids are asked until July 3 for 300 tons 16 to 4-in. cast iron pipe. R. Fletcher, Engr.

BOSTON, MASS.—The state board of health has been directed to investigate the question of a supply for this city and its suburbs within a radius of ten miles from the state house, also for such other cities and towns as in its opinion should be included in connection therewith, and to report to the legislature, with plans and estimates, on or before January, 1895. The board is authorized to employ engineers and to incur all necessary expenses.

CHICOPEE, MASS.—The contracts for dams, pipe-laying and building the earth and stone works for the new system has been awarded to Latham & Taylor, Northampton, at about $25,000.

HOLYOKE, MASS.—The state board of health has been petitioned for authority to secure a supply from a brook in Granville. This would require 11 miles of conduit; estimated cost, $225,000.

MELROSE, MASS.—The town has been authorized to issue bonds for $50,000 for extensions.

MILLBURY, MASS.—The Millbury Water Co. will take immediate steps to secure a supply.

TAUNTON, MASS.—The contract for a pumping station at the Lakeville ponds has been awarded to L. M. Witherell, who has sublet it to Abram Briggs, at $10,747. The contract for 6,000 ft. of pipe between the two ponds has been awarded to Kenneth & McKay.

WALPOLE, MASS.—A daily supply of 1,000,000 gallons is proposed from a well. A stand-pipe, 20 × 110 ft., would be constructed.

WHITMAN, MASS.—The town has been authorized to take the waters of Silver Lake for an additional supply for its own use and that of the towns of Hanson and Pembroke, and to issue bonds for $125,000.

UNIONVILLE, CONN.—The contract for works has been awarded to the Connecticut Pipe Mfg. Co., New Haven.

WATERBURY, CONN.—The committee has decided upon a site for a storage reservoir. The dam to be constructed is estimated to cost $80,000 to $110,000, according to height. It was voted to use 30-in. pipe, unless the council shall agree to 36-in. which would cost about $10,000 more per mile, or $110,000 more for the 11 miles. The bid of the Warren Foundry & Machine Co., Phillipsburg, N. J., for four miles of pipe at $25.50 per ton, was accepted; also that of the Waterbury Steam & Gas Pipe Works for a 130-HP. boiler, at $700.

FLUSHING, N. Y.—Bids are asked until July 1 for furnishing and laying 6,800 ft. of 8 to 4-in. pipe. G. A. Roullier, C. E.

JAMESTOWN, N. Y.—The board of public works has recommended that works be constructed at an estimated cost of $250,000, including 20,000 ft. 16-in. pipe, 200,000 ft. 6-in. pipe and wells to yield a daily capacity of 5,000,000 gallons. The present works are owned by a private company.

LANCASTER, N. Y.—It is reported that mains will be laid in the principal streets this year.

ALLEGHENY, PA.—An additional 24-in. main is reported as soon to be built from the Howard St. pumping station to the tanks on Linden St.

BELLWOOD, PA.—An election will be held July 15 to vote on the question of works.

GREENCASTLE, PA.—It is reported that unless a local company is soon organized to secure a supply a franchise will be given to non-residents.

HOLLIDAYSBURG, PA.—The contract for pipe for the new line has been awarded to the National Foundry & Pipe Works, Scottdale, at $32,826.

McSHERRYSTOWN, PA.—The McSherrystown Water Co. has awarded the contract for works to Daniel O'Donnell, Columbia. The supply will be from springs and a 125,000-gallon stand-pipe will be constructed.

POTTSVILLE, PA.—The Pottsville Water Co. has decided to rebuild the Kaufman dam, near Frackville, and bids are being asked for the construction.

BALTIMORE, MD.—The city has contracted with Henry R. Worthington, New York, for a 10,000,000-gallon pump for the station at Gay and Wolf Sts., to cost about $38,000.

FORSYTH, GA.—Plans for works have been prepared by G. M. Eldridge and J. H. Haggerty, Americus.

RAYNE, LA.—It is reported that works are contemplated.

SHELBYVILLE, TENN.—The citizens voted June 22 in favor of works.

ARLINGTON HEIGHTS, O.—An election will soon be held to vote on the construction of works. Louis Steinkoenig, Pres. trustees.

BROOKLYN VILLAGE, O.—Bids are asked until July 18 for constructing mains. C. N. Collins, Vil. Clk.

ELMWOOD PLACE, O.—It is reported that an election will soon be held to vote on the construction of works and an electric light plant. P. W. Durr, Mayor.

NAPOLEON, O.—J. B. Strawn, Engr., informs us that the contract for a combined water-works and electric light plant has been awarded to Edmund S. Sykes, Minneapolis, at $49,467, on condition that bonds be sold within 60 days.

NORWOOD, O.—Bids are asked until July 24 for water-works bonds for $25,000. W. E. Wichgar, Clk.

SHREVE, O.—Bids are asked until July 8 for works, as stated in our advertising columns. David E. Foltz, Chn. trustees.

YOUNGSTOWN, O.—G. D. Hersey, Engr., and W. S. Hamilton, Supt. W.-W., have reported upon a supply from Mill Creek, at an estimated total expense of $283,000, exclusive of land, as follows: $138,000 for conduits, two reservoirs, etc.; $70,000 for pipe for high service distribution; $30,000 for two stand-pipes; $45,000 for pumping machinery.

CONNERSVILLE, IND.—The contract for new works has been awarded to Snyder & Williams, Dayton, O., at $18,221. This was the lowest of 22 bids.

UNION CITY, IND.—S. R. Bell, Cy. Engr., informs us that the mains have been extended about 3,000 ft., and that refunding water bonds will soon be sold.

MARCELLUS, MICH.—The council has appointed a committee to ascertain the cost of works.

SAGINAW, MICH.—An election will be held to vote on extensions to cost $100,000 in the west side of the city.

BELLEVILLE, ILL.—The franchise of the Farnum Water Co. has been extended one year.

DUNDEE, ILL.—It is reported that works will be put in at East Dundee, the supply being from springs.

PONTIAC, ILL.—The works of the Pontiac Water Co., built by John J. Hainsworth, Franklin, Ind., were tested May 15 and accepted June 16.

LAKE CITY, MINN.—The contract for works has been awarded to Thos. H. Botham, Winona, at $21,921.

SPRINGFIELD, MINN.—The city has voted to issue bonds for works and an electric light plant.

HAWARDEN, IA.—The city has voted to issue bonds for $8,000 for a stand-pipe.

SHERIDAN, WYO.—An election will be held July 11 to vote on the issue of $75,000 of bonds for works.

ST. LOUIS, MO.—The board of public improvements will receive bids until Sept. 19 for two pumping engines, and until July 11 for the iron work and gates of the Baden gate chamber.

NEW CASTLE, COLO.—Surveys for proposed works are being made by John Clark, Geo. Pearson and Elmer Sheeder.

EVERETT, WASH.—The works at Lowell are being enlarged to secure an additional supply.

GARFIELD, WASH.—A proposition has been made to put in works and an electric light plant for $21,000.

SACRAMENTO, CAL.—The board has prepared specifications for new works, and bids will be received July 23. B. U. Steinman, Pres. trustees.

SAN BERNARDINO, CAL.—The city has contracted with John L. Campbell for a supply from Lytle Creek.

VALLEJO, CAL.—The contract for reservoirs has been awarded to Phillips & Searle, San Francisco, at $30,486. The total bids were published last week.

COEUR D'ALENE, IDAHO.—Surveys for extensions are being made by B. C. Riblet, Spokane, Wash.

ARTESIAN WELLS.

MAQUOKETA, IA.—Bids are asked until July 3 for an artesian well. W. A. Blessing.

IRRIGATION.

PHOENIX, ARIZ.—The following persons are members of a committee to arrange for a meeting of the people of Salt River Valley to be called to secure a system of water storage for the valley: W. A. Daggs, Lehi; C. I. Robson, Mesa; Jas. Stinson, Tempe; E. F. Kellner, Phoenix.

NEW COMPANIES.—Peoria Canal Co., Gila Bend, Ariz.; $2,000,000; Pres., John H. Francis; Vice-Pres., N. R. Gillson; Treas., J. M. Rice.——West Riverside Land & Water Co., Colton, Cal.; R. R. Smith, A. Parks, Jose Jansen, all of West Riverside.

SEWERS.

BEVERLY, MASS.—J. I. Bowditch Boston, has been engaged as engineer of the proposed system.

NEWTON, MASS.—The board of aldermen has authorized the issue of $100,000 of sewer bonds.

MIDDLETOWN, CONN.—The citizens have voted to ask the legislature for permission to issue $350,000 of bonds for sewers.

NEW HAVEN, CONN.—The contract for the boulevard sewer has been awarded to A. Brazos & Sons, at $64,131.

STAMFORD, CONN.—The clerk of the borough will receive bids until July 15 for 6,000 lin. ft. 20 and 24-in. cast iron pipe sewer.

JAMESTOWN, N. Y.—The board of public works is reported as receiving bids for 45,000 lin. ft. of sewers.

POUGHKEEPSIE, N. Y.—The following bids have been received for the Matteawan Asylum sewer: P. H. Harrison & Sons, Newark, N. J., $10,833; Delafield Const. Co., New York, $11,404; I. T. Brown, New York, $11,486; John Morrell, Monawk, $13,067; Riley Bros., Troy, $13,685; G. W. Holdridge, Catskill, $18,141; John Doyle, Albany, $18,380; J. H. Edwards, Cornwall, $18,698.

MEDINA, N. Y.—McGregor & Hughes, Buffalo, have been awarded the contract for the West St. sewer, at $15,000.

NEW YORK, N. Y.—The commissioner of street improvements in wards 23 and 24 will receive bids until July 6 for completing the Melrose Ave. sewer. The board of public works will receive bids until July 6 for six sewers.

NORWICH, N. Y.—Wm. Mason, Clk. S. Com., informs us that the following bids were received June 22 for the proposed system, about 10 miles of 20 to 8-in. pipe sewers: J. Marsden, Utica, $56,041; Martin & Sullivan, Syracuse, $61,404; M. Sullivan & Co., Little Falls, $48,510; Troy Public Works Co., $62,288; Conover & Newton, Orange, N. J., $55,482; W. Grant Cook, New York, $60,962; Hillport & Ayers, Bound Brook, N. J., $56,624; A. D. McConnell, Bunalo, $49,446; Ryan & O'Brian, Niagara Falls, $63,910; M. Bennett, Utica, $55,758. The contract has been awarded to M. Sullivan & Co.

PLYMOUTH, PA.—Bids will be received until July 3 for a sewer in one street, including 1,400 ft. of 18-in. terra cotta pipe. J. D. Williams, Secy.

BRADFORD, PA.—Bids will be received until July 3 for 5,736 lin. ft. 15 to 10-in. and 7,000 lin. ft. 8-in. sewer. F. W. Dalrymple, Cy. Engr.

LANCASTER, PA.—The street committee will receive bids until July 3 for three sewers. S. C. Slaymaker, Cy. Engr.

WASHINGTON, D. C.—The district commissioners will receive bids until July 7 for sewer brick, sand, etc.

BRIGHTWOOD, D. C.—The district commissioners have been petitioned to build an intercepting sewer from Brightwood Park along Piney Branch.

CHARLESTON, S. C.—Samuel M. Gray, Providence, R. I., has been in the city consulting with the municipal authorities about an improvement of the system.

COLUMBIA, S. C.—R. Frank Hartford, Atlanta, Ga., is consulting with the sewerage committee concerning surveys for a system.

HUNTSVILLE, ALA.—It is reported that the city council has made appropriations for a new system.

MACON, GA.—The citizens have voted to issue the $200,000 of sewer bonds referred to last week.

MERIDIAN, MISS.—Samuel M. Gray, Providence, R. I., has prepared plans for a separate system; total length, 333,650 ft.; estimated cost, $241,412. N. M. Brandon, Cy. Engr.

NEW ORLEANS, LA.—The New Orleans Sewerage Co. will receive bids until July 24 for sewers, as stated in our advertising columns.

BROOKLYN VILLAGE, O.—Bids are asked until July 18 for constructing sewers. C. N. Collins, Vil. Clk.

BUCYRUS, O.—Bids are asked until July 11 for 10,815 ft. drain tile, 7,000 sewer brick, etc. Henry L. Weber, Cy. Engr.

HAMILTON, O.—John W. Hill, Cincinnati, has been engaged as consulting engineer for a system.

SALEM, O.—The contract for 2,400 ft. of brick sewer has been awarded W. J. Gawne, Cleveland, at $8,950. F. W. Allison, Cy. Clk.

FRANKFORT, IND.—Chas. C. Brown, New York, has been engaged to prepare plans for a complete system.

SOUTH BEND, IND.—Wm. M. Whitten, Cy. Engr., has prepared plans for about two miles of 48 × 57-in. to 90-in. brick sewer, and the declaratory resolutions for the construction are to be considered at the next meeting of the council.

MORRISON, ILL.—Bids will be received until July 1 for 6,092 ft. 24 to 8-in. pipe sewer, as stated in our advertising columns. M. V. R. Smith, Mem. Com.

GREEN BAY, WIS.—The council has voted to construct a sewer in Webster Ave.

WACO, TEX.—The city engineer is making surveys for extensions.

SAN JOSE, CAL.—Bids will be received until July 18 for a sewer at the State Insane Asylum. L. G. Nesmith, Secy.

STREETS.

PITTSFIELD, MASS.—The board of aldermen has appropriated $6,000 for regrading West St.

MIDDLETOWN, CONN.—A special city meeting has been held to discuss the issue of bonds for $150,000 for street improvements.

AMSTERDAM, N. Y.—The council has voted to widen Bridge St for the overhead crossing, the estimated cost being $100,000.

BROOKLYN, N. Y.—Bids will be received until July 5 for grading and paving with cobblestones. John P. Adams, Comr. Cy. Wks.

GLOVERSVILLE, N. Y.—The council will receive bids until July 3 for paving with asphalt.

HORNELLSVILLE, N. Y.—Bids will be received until July 5 for paving 25,000 sq. yds. with vitrified brick, as stated in our advertising columns. F. A. Dunham, Engr.

NEW YORK, N. Y.—The board of aldermen has voted to pave three streets with granite blocks and two with trap-blocks.—The board of estimate has set apart $1,500,000 for street paving.

NEW UTRECHT, N. Y.—The town board has authorized the opening of five streets.

ROCHESTER, N. Y.—The council has voted to pave Swan St. with brick, to cost $5,500.

SYRACUSE, N. Y.—The council has awarded the contract for paving Sabine St. to John M. Mack & Co., at $9,347.

UTICA, N. Y.—The city surveyor will prepare plans for paving Rutger St. with asphalt.

YONKERS, N. Y.—Bids will be received until July 17 for the extension of Warburton Ave.

BROOKVILLE, PA.—Bids are asked until July 7 for 13,500 sq. yds. paving, brick to be furnished by the borough. R. Arthurs, E. English, Com.

HUNTINGDON, PA.—We are informed by David S. Black, Ch. Burgess, that the city engineer has prepared plans for street work for which bids will be received until July 10. J. M. Africa, Engr.

LANCASTER, PA.—The street commissioners will receive bids until July 3 for paving and macadamizing. S. C. Slaymaker, Cy. Engr.

PITTSBURG, PA.—The council has authorized the grading and paving of eight streets.

WILLIAMSPORT, PA.—The T. B. Townsend Co., Zanesville, O., has been awarded a contract for paving, at $40,000.

WILMINGTON, DEL.—The street department will receive bids until July 5 for setting curb and paving. H. J. Wiley, Secy.

BALTIMORE, MD.—Bids will be received until July 3 for repaving St. Paul St. with asphalt. A. E. Smyrk, Cy. Comr.—Bids will soon be asked for paving Maryland Ave. with Belgian blocks.

HUNTINGTON, W. VA.—W. E. Williams, C. E., informs us that the city has voted to issue $25,000 of additional bonds for street paving.

LOUISVILLE, KY.—The council has voted to pave eight streets with brick or block pavement.

BUCYRUS, O.—Bids will be received until July 11 for paving two streets, the work including 15,540 sq. yds. brick paving upon 2 ins. sand and 6 ins. crushed stone, 9,609 lin. ft. 4 × 20-in. curbing, 11,210 cu. yds. excavation, etc. Harry L. Weber, Cy. Engr.——The council has voted to have Center Cemetery St. improved.

CINCINNATI, O.—The board of administration will receive bids until July 5 and 14 for street improvements. A contract for paving with brick has been awarded to T. J. Peter, at $34,073.——The board of aldermen has voted to pave Allison St. with asphalt, to cost $10,103, and Liberty St. with granite, to cost $13,464.

CLEVELAND, O.—The council has voted to grade and pave several streets.

HAMILTON, O.—The council has ordered the city engineer to prepare plans for paving High St. with brick.

PORTSMOUTH, O.—The council has voted to grade and pave Market St.

SANDUSKY, O.—The council has awarded the contract for paving Market St. with brick to Jacobs & Stewart, Norwalk.

TOLEDO, O.—Bids will be received until July 24 for paving Galena St. with brick. Sylvester Lamb, Cy. Clk.

YOUNGSTOWN, O.—The council has voted to improve Lett St. J. H. Edwards, Cy. Clk.

ELWOOD, IND.—Paving, to cost about $23,000, has been ordered re-advertised.

EVANSVILLE, IND.—The board of public works will receive bids until July 8 for improving six streets.

FORT WAYNE, IND.—Bids will be received until July 11 for grading and paving 14 streets. F. M. Randall, Cy. Engr.

INDIANAPOLIS, IND.—The board of public works will receive bids until July 3 for paving two streets with asphalt, and until July 7 for paving with brick.——Two streets will be improved by grading and gravelling. Additional paving with asphalt and brick has been petitioned for.

NEW ALBANY, IND.—Bids will be received until July 17 for grading and paving. Wm. A. Broecker, Mayor.

SOUTH BEND, IND.—Bids will be received until July 24 for about 30,000 sq. yds. of brick paving. Action will soon be taken on 20,000 sq. yds. more. W. M. Whitten, Cy. Engr.

DETROIT, MICH.—Bids will soon be asked for $100,000 of boulevard improvement bonds.——The committee on streets has recommended that four streets be paved with cedar block on concrete.

DANVILLE, ILL.—The council has voted to grade and pave ten streets.

ASHLAND, WIS.—The council has voted to pave Second St.

MILWAUKEE, WIS.—Plans are prepared for a new street to be built along the river by Adolph Meinecke, at a cost of $150,000. The matter will soon come before the council.

CEDAR RAPIDS, IA.—The board of public works will receive bids until July 5 for paving with brick.

MINNEAPOLIS, MINN.—The council has ordered the paving of three streets.

LEAVENWORTH, KAN.—The estimated cost of paving the North Esplanade is $14,958.

KANSAS CITY, MO.—The board of public works has voted to pave four streets and macadamize one street.——The council will be petitioned to widen Walnut St.

PORTLAND, ORE.—A number of streets have been ordered improved, including one to cost $67,097.

TACOMA, WASH.—The board of public works has recommended that Pacific Ave. be paved, and bids will soon be received for the work.

ELECTRIC LIGHT AND POWER.

WINCHESTER, MASS.—T. S. Spurr, J. F. Dorsey and D. Nelson Skillings have been appointed to act as a municipal light board.

WOONSOCKET, R. I.—The Woonsocket Electric Machine & Power Co. has been authorized to furnish electric light and power in the towns of Bellingham, Mass., and Franklin, Mass.

BATAVIA, N. Y.—Geo. Perrin, Clk., informs us that the city is about to put in a plant for 73 arc lights. An election was held June 26 to vote on the issue of bonds for $23,000 for the purpose.

NIAGARA FALLS, N. Y.—The contract for furnishing the city with electric arc lights for five years has been awarded to the Buffalo & Niagara Falls Electric Light & Power Co., at $90 per light per year. The other bids were as follows: Brush Electric Light Co., $69; Power City Illuminating Co., $91.25; Brush Electric Light Co., Cleveland, O., by W. S. Rogers, $88; Frank Leblond & Co., $90. The city is now paying the Brush Electric Light Co. $75 per light per year.

ROME, N. Y.—Chas. C. Hopkins, Cy. Engr., is a member of a committee authorized to employ an electrical engineer to prepare estimates for a municipal electric light plant. No engineer has yet been engaged. The city is at present paying 33 cts. per light per night (over $16,000 per year), the lights burning an average of ten hours for 27 nights per month.

WASHINGTON, D. C.—The district commissioners will receive bids until Aug. 1 for lighting the streets of the district for ten years.

FORT WHITE, FLA.—The Fort White Phosphate Co. will put in an electric light plant.

IONIA, MICH.—Bids are asked until July 10 for lighting the city for ten years from Oct. 1. The city

is at present using 50 arc lights. Fred Cutler, Jr., Cy. Clk.

URBANA, ILL.—Bids are asked until July 3 for a franchise for an electric light plant and for public lighting for seven years. C. B. Holmes, Cy. Clk.

KANSAS CITY, KAN.—The Inter-State Water & Electric Power Co. will soon commence work on the proposed dam across the Kaw River near Muncie. It is proposed to construct an electric plant to furnish power for street railways, factories and for light in this city and Kansas City, Mo.

NEW COMPANIES.—Young Moskowitz Ry. Car Electric Lighting Co., Newark, N. J.; $1,000,000; C. A. Sterling, East Orange; F. C. O'Reilly, Orange; L. D. Adler, Newark.——Electric Light, Heat & Power Co., Gettysburg, Pa.; $25,000; Pres., E. M. Hoffer.——Kenosha Electric Light Co., Kenosha, Wis.; $15,000; E. G. Hazleton, Lewis Bain, U. J. Lewis.

CONTRACT PRICES.

WATER-WORKS SUPPLIES.—Rutland, Vt.—The contract for extensions has been awarded to Inman Bros., New York, at the following prices: 12-in. pipe, $1.42 per lin. ft.; 8-in., 90 cts.; 6-in., 64 cts.; 4-in., 49 cts.; 4-in. valves, $12; 6-in., $16; 8-in., $25; 12-in., $38; 16-in., $70; hydrants, $25; special castings, 1½ cts. per lb.

Dunkirk, N. Y.—The contract for extending the influent pipe into the lake has been awarded to Thatcher & Breyman, Toledo, O., as follows: Crib, complete, including riprap, $.80; submerged pipe laying between works and pier, $4 per lin. ft., and between pier and crib, $5 per lin. ft.; laying pipe through pier, $500; rock excavation, $12 per cu. yd.; bolts to secure pipe, $15 per set. The bids for pipe, 24 and 30-in., ranged from $19.10 to $21.75 per ton, and for specials from 2.3 to 2.75 cts. per lb.; 24-in. valves, at $110; 30-in., $175.

Montreal, Que.—The contract for 210 tons of special castings has been equally divided between W. Rodden & Co. and Pascal Amasse, at $61.60 per ton.

Colorado Springs, Colo.—The contract for cast iron pipe has been awarded to the Colorado Fuel & Iron Co., Bessemer, at $24.50 per ton for pipe and $52.50 for special castings f. o. b. cars at Bessemer, conditioned upon the sale of bonds within 60 days. Bids were received for 240 lin. ft. 14-in. pipe, 7,100 lin. ft. 12-in., 6,880 lin. ft. 10-in., 13,300 lbs. special castings and 48 valves. The prices for valves ranged as follows: 6-in., $12 to $13.75; 8-in., $18 to $20; 10-in., $26 to $28.40; 12-in., $32.50 to $39.10; 14-in., $54 to $65. H. I. Reid, Cy. Engr.

PIPE, PIPELAYING, ETC.—Swampscott, Mass.—The following bids have been received for furnishing and laying about 3,000 lin. ft. of cast iron water pipe and appurtenances: H. Scott Tuttle, Swampscott, 6-in. pipe, laid, 85 cts. per lin. ft.; hydrants and setting, $35; gate valves, boxes and setting, $20; T branch, laid, $5; plugs, laid, $1. F. D. Mayo & Co., Lynn, $35; gate valves, boxes and setting, $20; T branches 90 cts., $40, $18, $4.50, $1.50, respectively; Henry F. Burt, Taunton, $1.35, $35, $25, $7, $1.

CHANNEL.—Brookline, Mass.—The total bids received for the Village Brook channel were published in our issue of June 8, the contract being awarded to F. A. Snow: 1, Jas. Killian, $67,817; 2, H. P. Nawn, $50,327; 3, M. O'Connor and F. L. White, $47,362; 4, F. A. Snow, $41,345. The prices were as follows, the town furnishing all cement and castings:

	1.	2.	3.	4.
Earth excavation, 17,000 cu. yds., at	$2.00	$1.50	$1.18	$1.00
Rock excavation, 100 cu. yds., at	7.00	1.00	5.00	1.00
Piling, 1,500 lin. ft., at	1.40	.20	.20	.20
Timber foundation, 40 M ft. B. M., at	31.00	30.00	30.00	30.00
Sheeting, left, 20 M ft., B. M., at	18.00	16.00	10.00	1.00
10-in. underdrain, 1,500 lin. ft., at	1.00	.50	.75	.30
Rubble masonry, 1,200 cu. yds., at	5.50	5.50	4.50	5.00
Concrete, Am. cement, 900 cu. yds., at	6.00	4.25	3.75	5.00
Concrete, Portland cement, 1,200 cu. yds., at	6.00	5.00	3.75	5.00
Brickwork, 200 cu. yds., at	10.00	14.00	12.00	11.00
Granite pavement, 300 sq. yds., at	3.75	2.75	2.00	3.00
Plastering, Port. cement, 2,200 sq. yds., at	.30	.25	.10	.20
Rubble masonry outlet, 50 cu. yds., at	6.00	5.50	4.50	6.00
Cut granite outlet, 6 cu. yds., at	300.00	45.00	240.00	120.00
15-in. sewer pipe, 70 lin. ft., at	2.75	.60	2.00	1.50
12-in. sewer pipe, 220 lin. ft., at	2.50	.50	2.00	1.50
8-in. sewer pipe, 300 lin. ft., at	2.25	.60	1.50	1.25
6-in. sewer pipe, 100 lin. ft., at	1.75	.50	1.00	1.00
1 catch basin, at	55.00	35.00	15.00	30.00
8-in. chutes, 100 lin. ft., at	2.10	.50	.25	1.00
Placing ironwork, at	30.00	50.00	100.00	50.00
Retaining wall restored, 75 cu. yds., at	9.00	3.00	4.50	7.00
Surplus earth removed, 1,000 cu. yds, at	1.50	.50	.25	.20

MACADAMIZING.—East Hartford, Conn.—The selectmen have awarded a contract for four miles of macadamized road to J. S. Lane & Son, Meriden, at about $6,000 per mile, as follows: All stone to be from Meriden quarry; 63 cts. per sq. yd. for finished road, 7 ins. deep in center and 5½ ins. on sides, or 56 cts. per sq. yd. for 6 ins. center and 4½ ins. on sides.

ASPHALT PAVING.—Mount Vernon, N. Y.—The contract for paving 9,300 sq. yds. in Fourth Ave. with asphalt has been awarded to the Barber Asphalt Paving Co., at $2.80 per sq. yd. for paving, 50 cts. per lin. ft. for new curbing and 8 cts. for old curbing. The Warren-Scharf Asphalt Paving Co. bid $2.95, 45 cts. and 12 cts., respectively.

Indianapolis, Ind.—Contracts for paving Illinois St. with asphalt have been awarded as follows: Warren-Scharf Asphalt Paving Co., 2,368 lin. ft., 50 ft. wide, at $9.96 to $10.71 per lin. ft., according to curbing; Western Paving & Supply Co., 3,749 lin. ft., 45 ft. wide, at $8.66 to $8.90.

Portland, Ore.—The following bids were received June 17 for paving Morrison St.: Trinidad Asphalt Paving Co., asphalt, 22¼ cts. per sq. ft.; concrete, 12 cts. per sq. ft.; artificial stone curb, 45 cts. per lin. ft.; grading fill crushed rock, $2 per cu. yd.; grading cut, 45 cts. per cu. yd; total, $53,822. Portland Bituminous Paving & Improvement Co., 23.2 cts., 11.5 cts., 40 cts., $1.75, 95 cts., $53,894, respectively.

ASPHALT BLOCK PAVING.—Baltimore, Md.—A contract for paving with asphalt blocks has been awarded to the Maryland Paving Co., at $2.50 per sq. yd.

BRICK ARCH.—Cohoes, N. Y.—The only bid received for an arch over Eagle's Nest ravine was that of Wm. Connors, as follows: Brick work, $11.50 or $12.20 per M. bricks, for Rosendale or Portland cement, respectively; excavation, $2 per cu. yd.; filling, 35 cts. per cu. yd.

CRUSHING STONE.—Lock Haven, Pa.—The contract for crushing 1,500 tons of stone and delivering it on the streets has been awarded to Adam Kamp, at 25 cts. and 50 cts., respectively, per gross ton.

BRICK PAVING.—Des Moines, Ia.—Several contracts have been awarded to N. W. Smith, at $1.52 per sq. yd. for two courses of brick, and $1.68 for one course on concrete.

Charleston, W. Va.—John F. Palmer has been awarded a contract for paving in three streets with McMahon, Porter & Co.'s brick, at $1.18 per sq. yd.

PAVING BRICK.—Washington, D. C.—The district commissioners have awarded a contract for 500,000 paving brick to the Frederick Brick Co., at $9.75 per M.

GRANITE CURBING.—Minneapolis, Minn.—The contract for about 15,720 lin. ft. granite curbing for the coming season has been awarded to J. E. Snyder, at 81 cts. per lin. ft.

GRANITE BLOCK PAVING.—Lancaster, Pa.—A contract for paving with Belgian blocks has been awarded to J. G. Galbraith, at $2.88 per sq. yd.

GRANITE BLOCKS, ETC.—Haverhill, Mass.—The contract for 400,000 granite paving blocks has been awarded to Thos. Lahey, at $90 per M. for Rockport granite. Other bids ranged from $48.50 to $71 per M. Thos. Lahey was also awarded the contract for edgestones and flagging, at 46 cts. per lin. ft.

MISCELLANEOUS.

DITCH.—Chicago, Ill.—Bids are asked until July 10 for a drainage ditch in the towns of Rich and Frankfort. J. T. Foster, Engr., 94 La Salle St.

PIER WORK, ETC.—New York, N. Y.—The department of docks will receive bids until July 6 for removing the existing pier and building a new wooden pier at the foot of West 15th St., North River, including about 244,500 ft. B. M. yellow pine timber, 68,703 ft. B. M. spruce timber, 22,618 lbs. wrought iron dock spikes, etc.; also for an iron awning shed at the foot of East 33d St., East River, and for paving and draining.

DREDGING.—Wilmington, Del.—Bids will be received at the U. S. Engineer Office until July 18 for dredging and excavating for an inland waterway from Chincoteague Bay, Va., to Delaware Bay, Del. Wm. E. Smith, U. S. Agt.

Philadelphia, Pa.—The commissioners of Fairmount Park will receive bids until July 3 for dredging the river and laying water pipe in West Fairmount Park.

Philadelphia, Pa.—The council has appropriated $20,000 for dredging in the Schuylkill River.

DAM.—Wilkinsville, Mass.—The contract for a stone dam across the Blackstone River at this place has been awarded to Cutting, Bardwell & Co., Worcester, at $10,800. Chas. A. Allen, Worcester, prepared the plans.

Laconia, N. H.—The mill owners have been securing plans and estimates for rebuilding the dam in the Merrimac River at this place; estimated cost, $35,000, or, including electric plant, $60,000. The work is reported as to be done in the fall.

LOCKS AND DAMS.—Charleston, W. Va.—The contract for locks and dams Nos. 9 and 10 of the Great Kanawha River improvement has been awarded to Zimmerman, Truax & Sherman, Duluth, Minn., and that for No. 11 to Thos. Munford, who built No. 4, just below St. Albans. The lowest total bids for Nos. 10 and 11 were published in our issue of May 4, and the itemized prices of No. 11 received at a previous opening of bids in our issue of March 16. These locks will cost over $1,000,000 and are to be completed by Dec. 31, 1896.

Cincinnati, O.—The following contracts have been awarded for dikes and dams on the Ohio River: L. & J. L. Cramer, work at Chester's, $18,110, and at Scuffleton $9,434; Wm. Kirk, work at French Island $83,428, and near mouth of Tradewater River $10,540; Frederick Hartweg, work near Mound City, $16,636.

Minneapolis, Minn. It is reported that work will soon be commenced on the two docks and dams to be constructed in the Mississippi River, between this city and St. Paul, at an estimated cost of $1,000,000.

IMPROVEMENT BONDS.—Moscow, Idaho.—The city has sold $45,000 of bonds for public improvements.

GAS LIGHTING.—Montreal, Que.—Bids are asked until July 11 for laying gas mains and supplying gas to the citizens. L. O. David, Cy. Clk.

GAS COMPANY.—Camden, N. J.—The American Gas Light Co. has been incorporated by W. S. Boody, H. C. Robinson and others; capital stock, $250,000.

NATURAL GAS COMPANY.—Buffalo, N. Y.—The South Buffalo Natural Gas Co. has applied to the city council for a franchise. It has five wells about 3½ miles distant from the city limits, each of which has an estimated volume of 1,000,000 cu. ft. of fuel gas per day, and the maximum price to be charged is 25 cts. per 1,000 cu. ft. Pres., Philip W. Roth; Treas., R. W. Argue; Gen. Man., E. M. Cobb; capital stock, $300,000.

JETTY.—San Diego, Cal.—It is reported that Col. W. H. H. Benyaurd, U. S. Engineer Office, will soon advertise for the construction of a jetty at the mouth of this harbor.

HARBOR IMPROVEMENTS.—Mobile, Ala.—Bids will be received at the U. S. Engineer Office until July 11 for improvements in Mobile Harbor and dredging in Mobile River. Maj. A. M. Damrell, U. S. A.

INDUSTRIAL NOTES.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have an order for three locomotives for the Cairo Short Line. A new shop, 50 x 200 ft., is being erected, the material being supplied by the Pottsville Iron & Steel Co., Pottsville, Pa.

The Richmond Locomotive Works, Richmond, Va., have an order for 20 engines for the Cleveland, Cincinnati, Chicago & St. Louis.

The Rogers Locomotive & Machine Works, Paterson, N. J., are building 12 engines for the Florida Central & Peninsular.

CARS.—The Roanoke Machine Works, Roanoke, Va., have delivered 300 hopper bottom coal cars and 13 cabooses to the Norfolk & Western.

The Harris Car Works, Amherst, N. S., have built 50 coal cars for the Dominion Coal Co.

The Cairo Short Line has added 200 coal cars to its equipment.

The Duplex Car Co. has been incorporated at Springfield, Ill., by H. C. Wilson, J. S. Friedmeyer and E. Knudson.

THE GOULD'S MFG. CO., Seneca Falls, N. Y., reports several recent orders for triplex pumps for paper stuff. One of these has a separate inlet and discharge connection for each plunger, and will be used to pump three different kinds of stuff in three different directions, the idea being to secure economy of floor space and compact construction. The Wasahburn shops, a department of the Tecnology Institute, Worcester, Mass., have ordered a triplex electric pump, to be operated by a Perret electric motor. The pump will supply sufficient water to operate two hydraulic elevators having pistons 5½ ins. diameter by 75 ft. run. The elevators will be operated on the pressure tank system at about 140 lbs. per sq. in., and will run at a speed of 400 ft. per minute.

NAPHTHA FUEL GAS PLANT.—The Staten Island Terra Cotta Lumber Co.'s plant, described in our issue of Feb. 16, has now equipped its kilns throughout with the fuel gas system of the International Gas & Fuel Co. The fuel used is gasoline or naphtha, which is converted into a fixed gas by apparatus invented by Mr. J. M. Goldsmith, of Chicago. The kilns of brick are burned in much less time than with the best coal, and the product is superior in color and quality. The saving in labor in handling coal and ashes, and tending the kilns is large, and the durability of the fireboxes is much increased. On April 4, a kiln of firebrick was opened which had been burned in 4 days 8 hours with the naphtha gas system as against 12 days with coal, and the product was fully 25% better in color and quality.

RUST PROOFING.—The South Brooklyn Rust Proof & Steel Works, G. W. Gesner, proprietor, are now re-opened, having been closed for enlargement and extension. The Gesner patent process is said to be entirely new and original and to have great advantages for the treatment of iron and steel to prevent corrosion or rusting through exposure to the weather, steam, damp earth, brine, etc. This process changes the body of the surface of the material into a compound of hydrogen, iron and carbon which does not scale off and alter dimensions, in addition to the prevention of rust. It is found that cast iron is annealed by the process and its pores filled. Cast iron pipe that has been treated will, it is said, withstand a pressure of 50 lbs. as compared to 5 lbs. by untreated pipe. The process is applicable in cases where tinning and galvanizing are now used and is very much less in cost. Certified tests from the Henry Warden Iron Works, Philadelphia, show that steel is also improved by the Gesner process.

TAYLOR IRON & STEEL CO.—This company is now prepared to take orders for car wheels of manganese steel, for the manufacture of which it has the exclusive right in the United States. The company is the development of the old Taylor Iron Works, of High Bridge, N. J., founded in 1868, and well known for many years for its manufacture of chilled iron and combination steel tired car wheels and car axles. Since 1890, when it secured the right to ues Hadfield's patent for the manufacture of high manganese steel in this country, the company has been actively increasing its plant and developing the use of the metal for cast car wheels and in general castings. In addition to car wheels, especial attention is being devoted to the manufacture of mine car wheels, steel pins for dredgers, etc., bridge pins, and steel projectiles for the United States Government. The company's works are located at High Bridge, N. J., with New York offices at 143 Liberty St. The officers are: Pres., L. H. Taylor; Vice-Pres., W. J. Taylor, and Treas., B. F. Budlong.

THE MICHIGAN BRASS & IRON WORKS, Detroit, Mich., have recently been awarded contracts as follows: Chicago, 25,000 corporation stop cocks; Cincinnati, O., contracts for corporation stop cocks; Detroit, Mich., corporation stop cocks and valves. Contracts for new water-works: West Knoxville, Tenn., 82 hydrants and the valves; Princeton, Ind., 60 hydrants and valves; Morgan Park, Ill., hydrants; Rockford, Ill., large valves; Mt. Carmel, Ill., 65 hydrants and valves.

THE J. H. & D. LAKE CO., manufacturing all kinds of friction clutch pulleys, has recently removed from its old quarters at Hornellsville, N. Y., to new offices and foundry at Massillon, O., where, with enlarged facilities, it is prepared to meet the growing demand of its business.

BUFF & BERGER, Boston, Mass., have at the World's Columbian Exposition an exhibit of transits, levels, electric current meters and other instruments, including some parts made of aluminum. The exhibit is on the gallery floor at the north end of the Manufactures Building.

THE GATLING ORDNANCE CO. will establish steel works and a gun factory at the new town of Gatling, near Buffalo, N. Y.

ROCK CRUSHER.—A champion rock crusher has been purchased by the city of Quincy, Ill., from Hunt & Adams.

THE CHAPMAN VALVE CO., Boston, Mass., has an exhibit of straightway valves and fire hydrants at main 26, K 28, in the Machinery Building, World's Columbian Exposition. The power station of the intramural electric elevated railway (Eng. News, April 6), is fitted throughout with Chapman valves.

NEW COMPANIES.—Columbia Railway Supply Co., Chicago, Ill.; $10,000; R. H. Mason, Geo. W. Trowbridge and W. B. McIntyre. Adamantean Rock Paving & Fireproofing Co., Denver, Colo.; $25,000; James O'Friel, H. H. Meserole and G. W. Fisher, Kewanee Soil Pipe Mfg. Co., Kewanee, Ill.; $30,000; G. Kremers and G. Schumacher. Pennsylvania Down Draft Furnace Co., Chicago, Ill., $300,000; C. E. Blayer, Josiah E. Cratty, and Walter Birdsall. Wadley Continuous Drawbar Co., Macon, Ga.; George D. Wadley. (See Engineering News, May 4, 1893). Chicago Hydraulic Dredging & Excavating Co., Chicago, Ill.; $1,000,000; M. Van Landingham, J. H. Miller and C. S. Cutler. Donahoo Steel & Smelting Co., San Francisco, Cal.; $500,000; P. B. Donahoo, Henry A. Jones and E. P. Gray.

Image Evaluation Test Target (QA-3)

In this Issue: Examples in GRAVING DOCK Construction (with inset) — DEEP SEA BORINGS for Prince Edward Island Tunnel.

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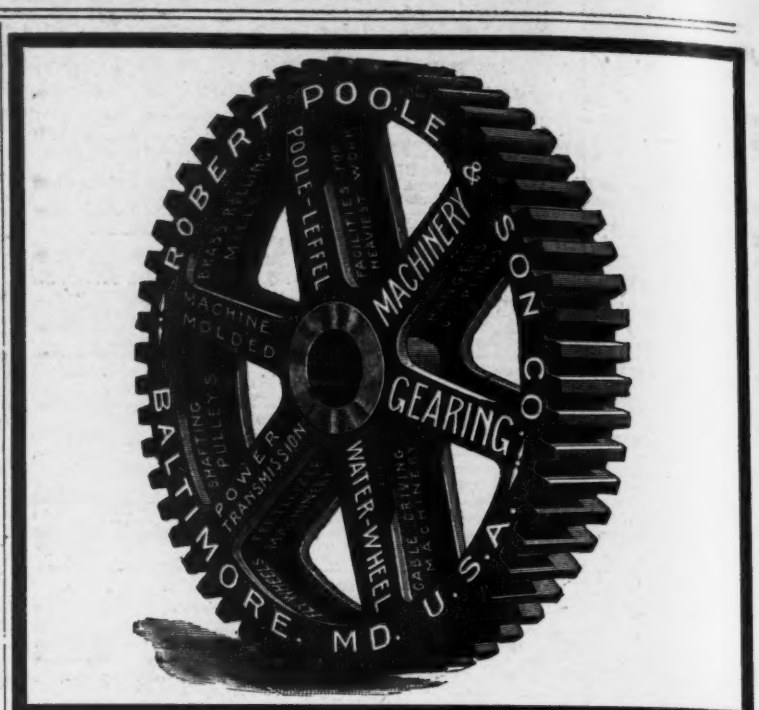

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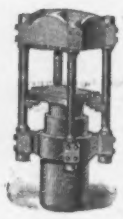

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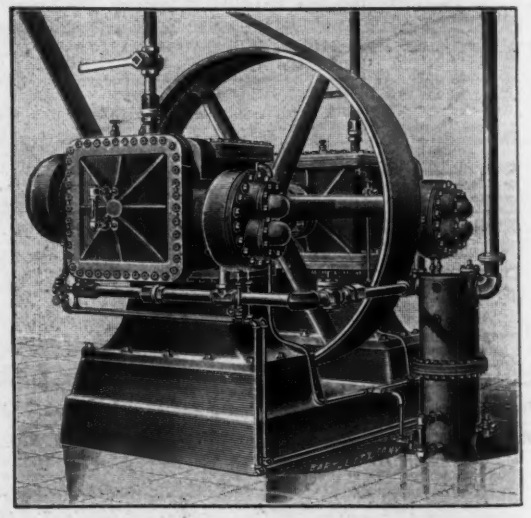
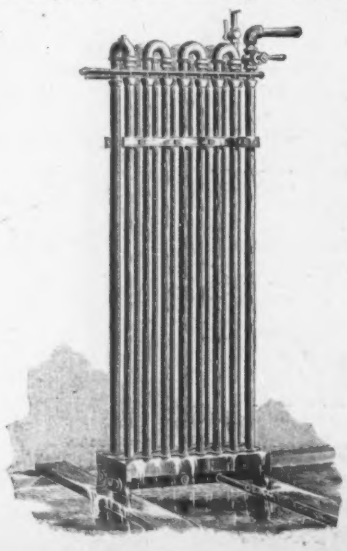


ARTIFICIAL ICE

having any capacity from one-half ton to one hundred tons per day, and upward. Artificial Ice has come to stay, equally for sanitary and economic reasons, and its manufacture is a stable and profitable enterprise, competing successfully against the natural product.



ARTIFICIAL REFRIGERATION

will receive our especial attention. In Cold Storage Warehouses, Breweries, Packing-Houses, and similar large industries, it is already an established necessity. Into this class of plants we bring for the first time the manifest advantages of small space and head-room, and the sub-division of units, which last is the only means whereby a Refrigerating Plant can meet the fluctuation of the seasons with anything like uniform efficiency.

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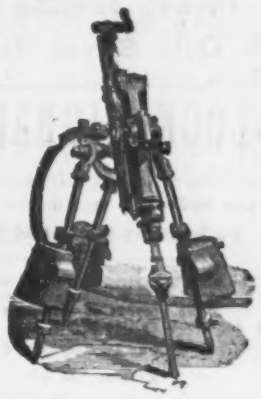

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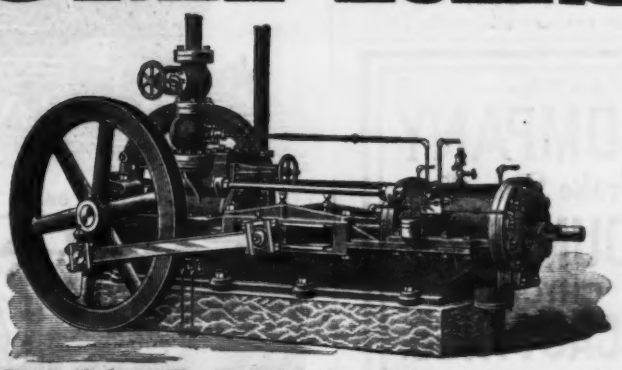

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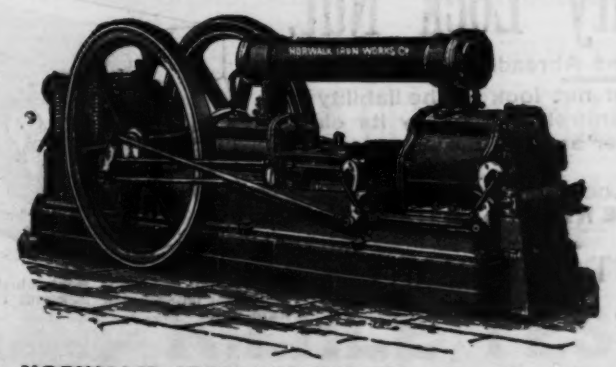

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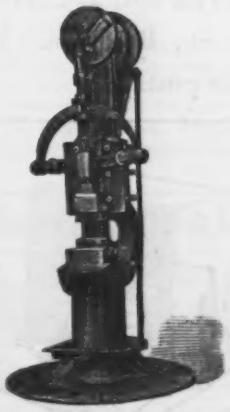

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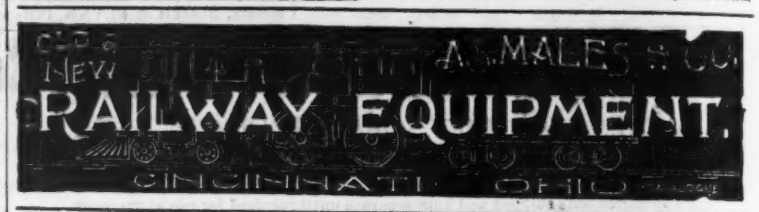

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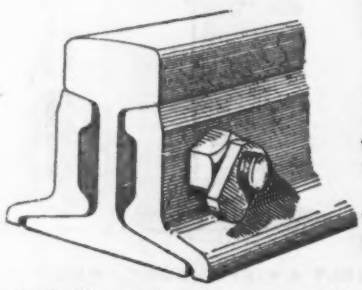

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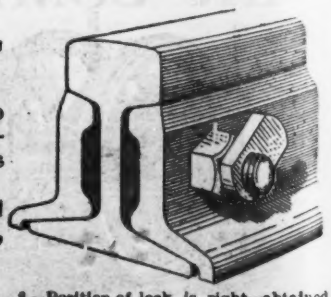

2.—Position of lock is right—obtained by turning outer face of lock (cut 1) toward nut.

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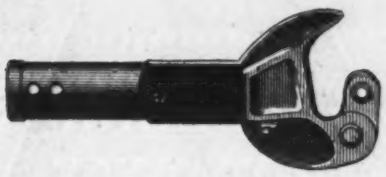

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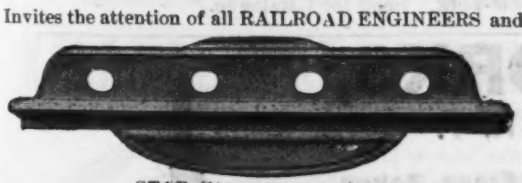

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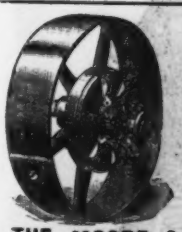

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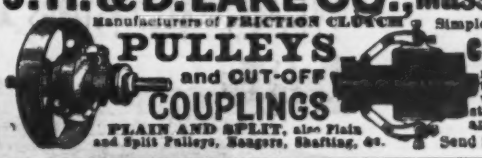

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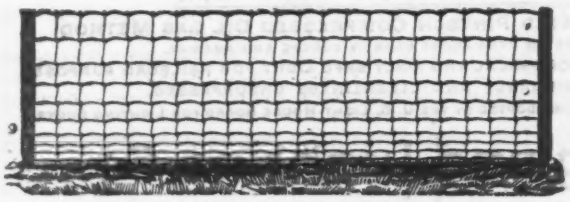

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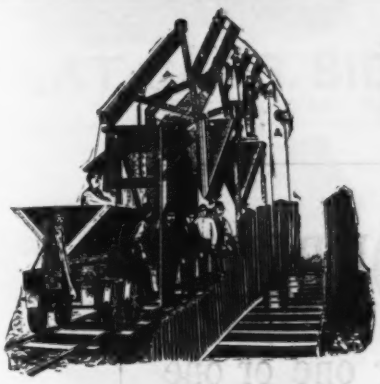

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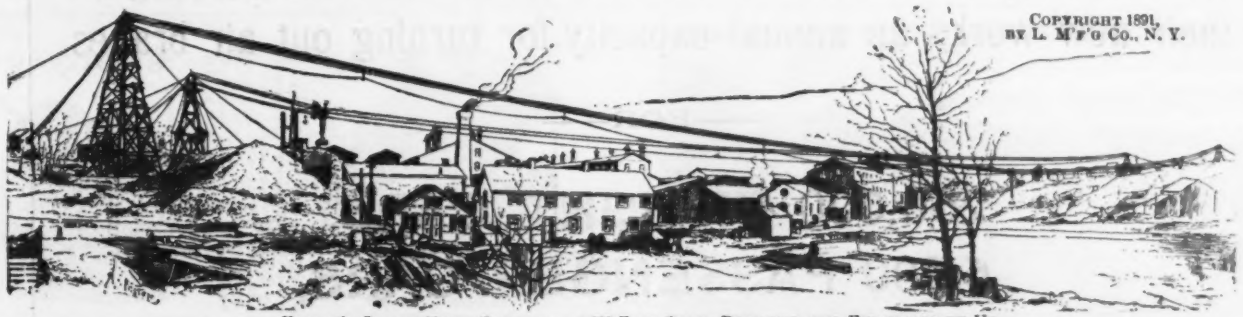

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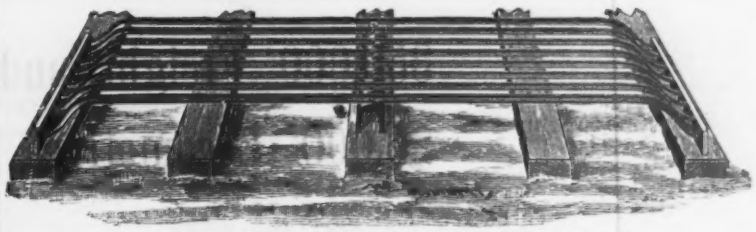

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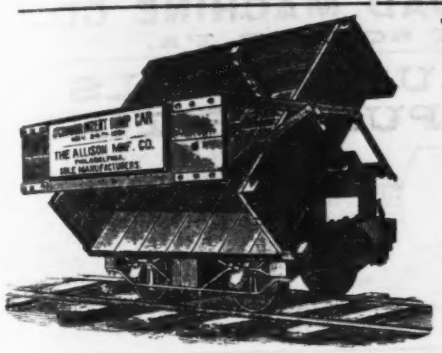

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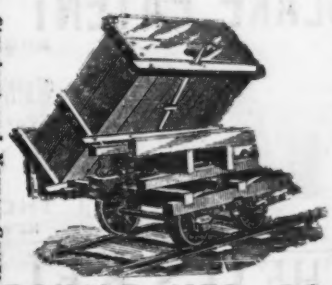

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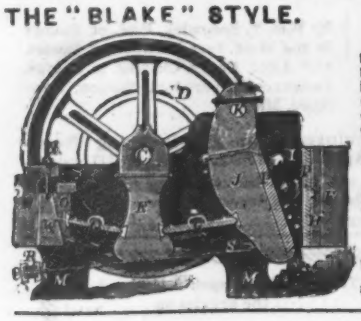

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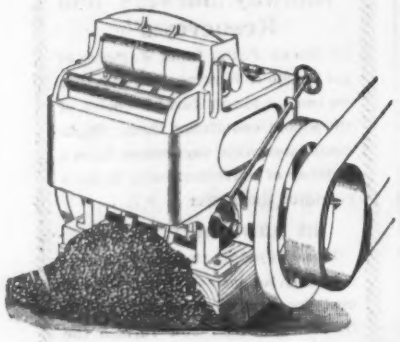

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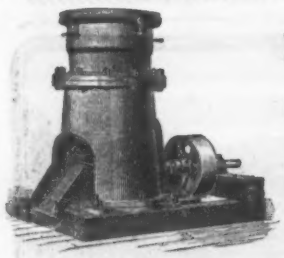

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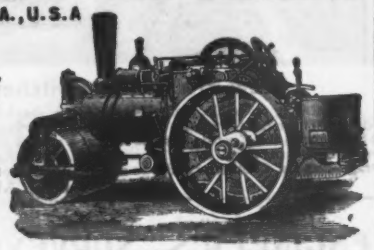

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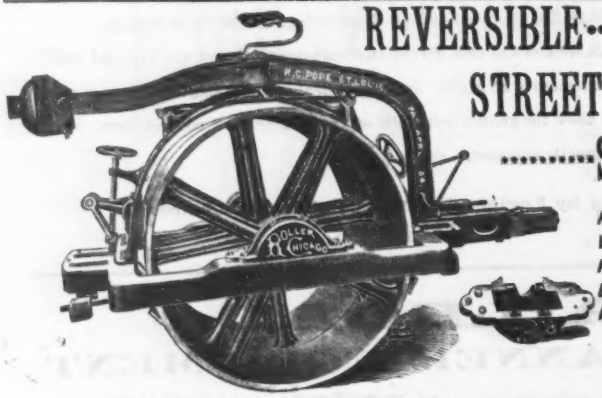

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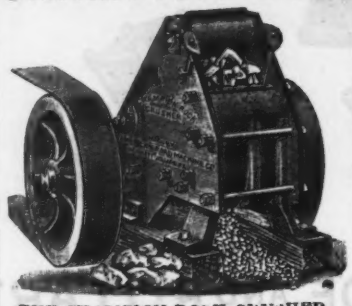

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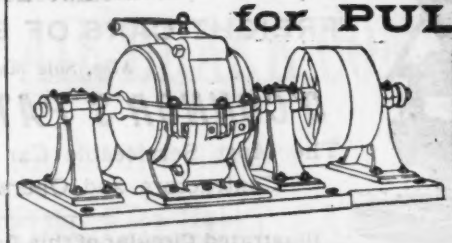

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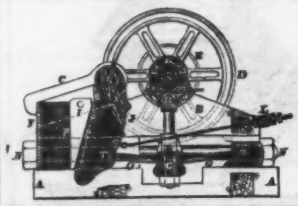

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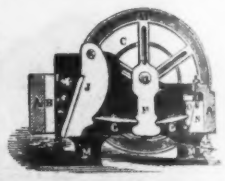

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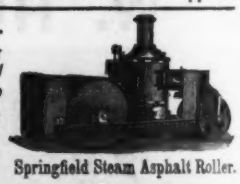

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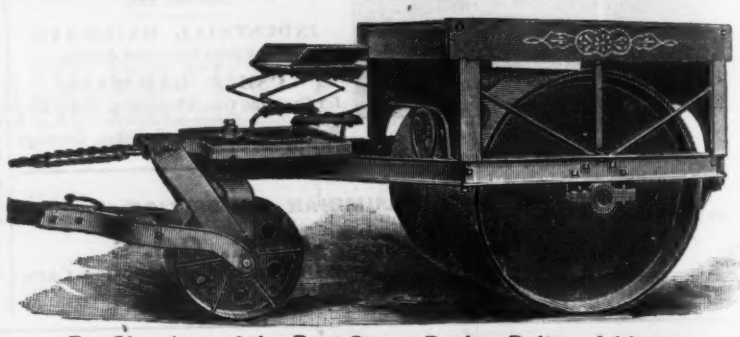

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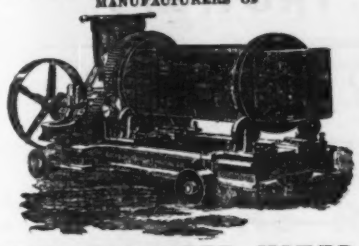

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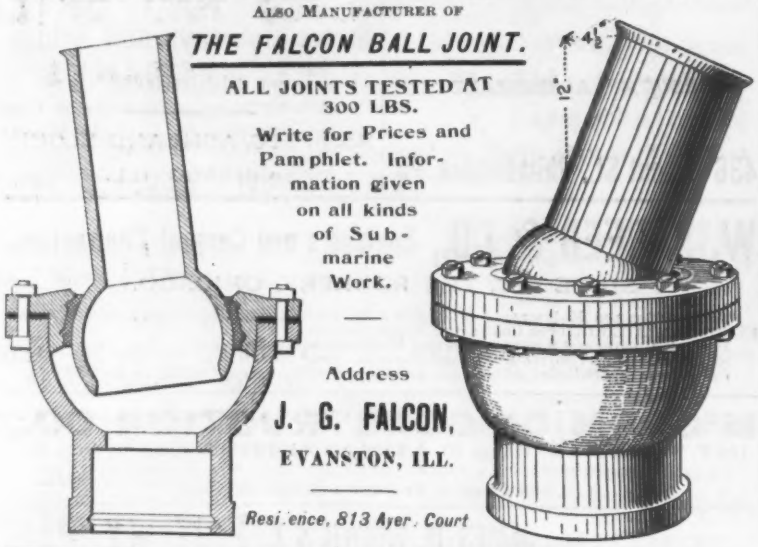

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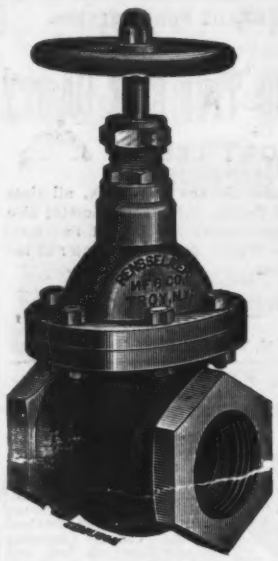

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Anvils, per pound	.11
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New York: $29 at eastern mills and at tidewater; old rails, $15 to $15.50 for iron, $12 to $12.50 for steel. Pittsburg: $29 for standard sections; old rails, $20 for iron and $13.50 to $15.50 for steel. Chicago, $30 to $32 for standard sections; old rails, $16 to $17 for iron and $10.75 to $14 for steel.

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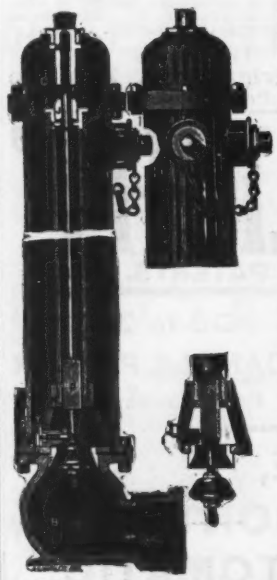

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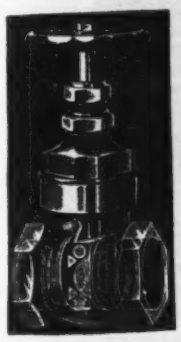

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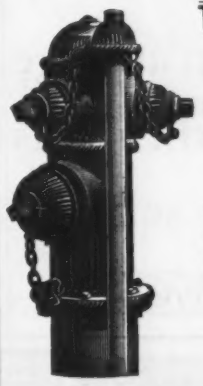

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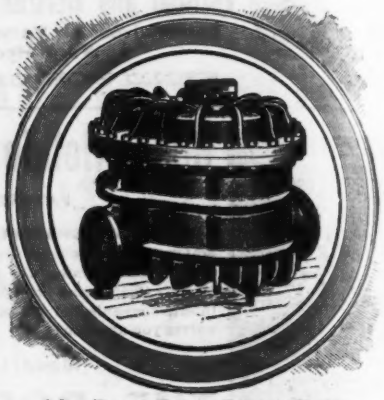

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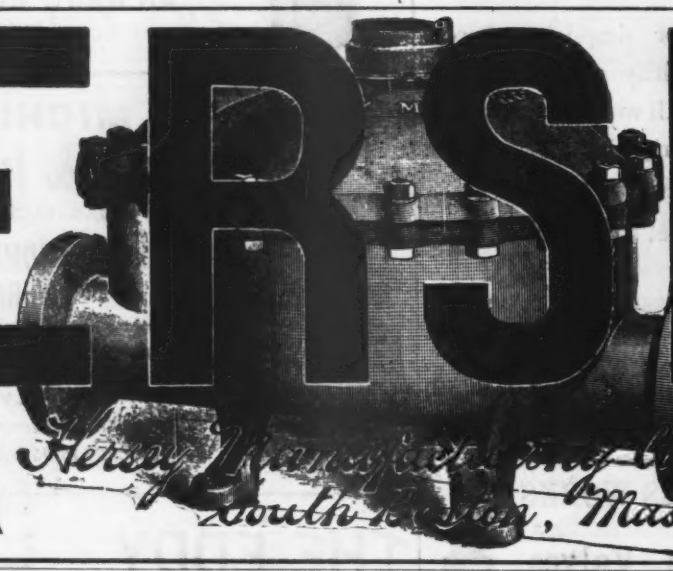

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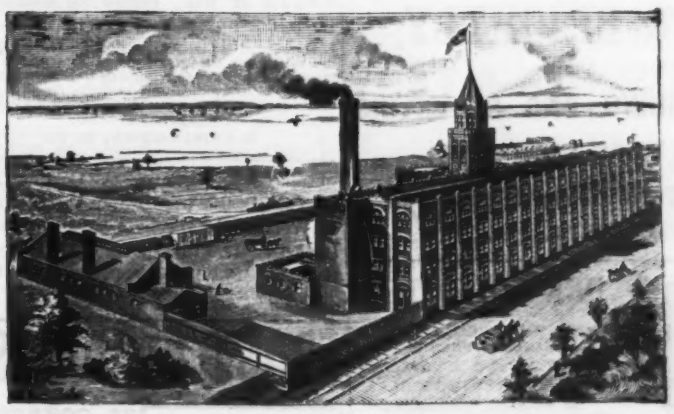

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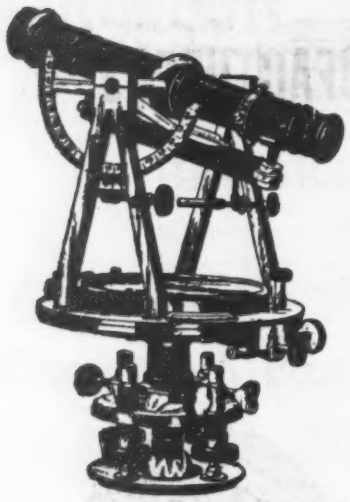

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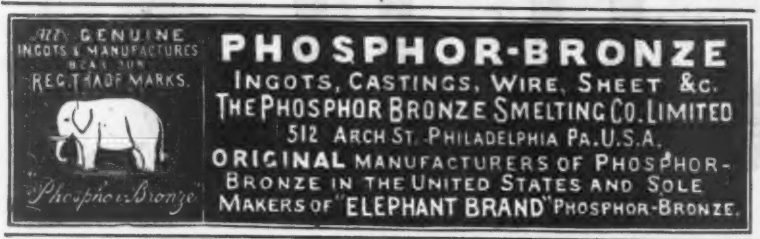

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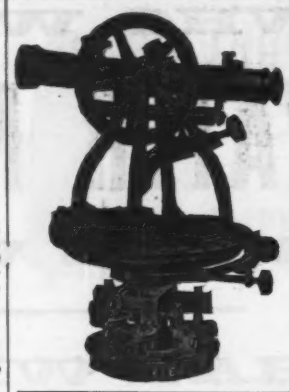

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GENERAL INDEX

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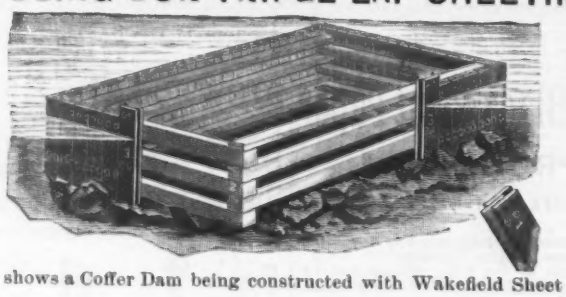

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NOTICE TO SEWER CONTRACTORS.

ILION, N. Y., SEWERAGE.

Sealed proposals will be received by the Board of Sewer Commissioners of the Village of Ilion until July 6th, 1893, at noon, for the construction of a sewerage system for said village, consisting of furnishing and laying about 10.6 miles of vitrified sewer pipe with its branches, and the construction of about 109 manholes, 78 lampholes, 40 flush tanks and other appurtenances.

Bids will be received for the entire work. Plans may be seen at the office of the Commission, Ilion, N. Y., and specifications procured of Anthony Steber, Secretary.

The Board of Sewer Commissioners hereby reserve the right to reject any or all bids, or to accept any that in their judgment will be for the best interests of the village.

Bonds satisfactory to the Board in amount and sureties will be required of the one to whom the contract may be awarded.

Cash or a certified check, made payable to the Board of Sewer Commissioners of Ilion, N. Y., to the amount of $500 must accompany each bid as a guaranty that, in case the contract is awarded, the party or parties to whom the award is made will, within five days after notification of award, execute said contract.

Bids must be sealed and addressed to Anthony Steber, Secretary of Sewer Commissioners, Ilion, N. Y., and marked "Proposal for Sewer Construction."

These proceedings are taken under the provisions of the General Village Sewer Act of 1889.

JOHN HOEFLER, Pres't.
ANTHONY STEBER, Sec'y.
GEORGE F. WILCOX,
M. H. STERLING,
GEORGE WILFERT,
Board of Sewer Commissioners.

Ilion, N. Y., June 12, 1893. 25-2t

WATER-WORKS AT SHREVE, OHIO.

Sealed proposals will be received until July 8, 1893, by the board of water-works trustees of Shreve, O., for the construction of a system of water-works in Shreve, O. Plans, specifications and contracts will be on exhibition at the clerk's office of the board of trustees after June 14, 1893.

Blank forms of plans, specifications and contracts will be furnished on application. Each bid must be accompanied by a certified check to the amount of $200 as a guarantee of good faith. The right to reject any and all bids reserved.

DAVID E. FOLTZ,
Chairman Board of Trustees,
25-2t

COMMONWEALTH OF MASSACHUSETTS.

METROPOLITAN SEWERAGE COMMISSIONERS.—NOTICE TO BUILDERS OF PUMPING ENGINES.

Sealed bids for the pumping plant for the pumping station at CHARLESTOWN will be received by the Board of Metropolitan Sewerage Commissioners at its office, 110 Boylston Street, Boston, Mass., until 12 o'clock m. of Saturday, July 1, 1893, and at that time will be publicly opened and read.

The Board will provide an engine-house, boiler-house, chimney and masonry foundations for the pumps, and will furnish a fresh water supply for the boilers up to the interior of the boiler-house. The contractor's bid must be for furnishing, setting up and completing, ready for use, two pumping engines (or sets of engines), two boilers, piping, and all necessary appliances and fittings, such as are to be found in pumping stations of the best class.

Each pumping engine must be capable of easily raising 35 cubic feet of sewage per second 11 feet vertically above the level of the sewage in its respective pump well. Each of the engines must also be capable of raising to greater lifts up to 30 feet, quantities of sewage inversely proportional to such lifts.

The contractors must provide at the station two steam boilers of such capacity that either of them can easily supply the necessary steam for the two engines when discharging together 70 cubic feet per second, with a lift of 11 feet.

The design of the pumping engines may be of any form which will fulfil the conditions named in the general specifications.

Each bid must be made on one of the blank forms furnished by the Board, and must be accompanied by a properly certified check for the sum of $1,000, the latter to be returned unless forfeited by abandonment of the proposal.

The Board reserves the right to reject any and all bids.

Plans, blank forms, general specifications and further information may be obtained at this office.

HOSEA KINGMAN,
TILLY HAYNES,
HARVEY N. COLLISON,
Board of Metropolitan Sewerage Commissioners of Massachusetts.
HOWARD A. CARSON,
Chief Engineer.

19-9t

UTICA PIPE FOUNDRY CO.

CAST IRON PIPE AND SPECIALS FOR WATER AND GAS.

Also flanged Pipe and Fittings, Hydrants, Gates, Pig Lead, etc. CHAS. MILLAR & SON, Selling Agents, Utica, N. Y. Manufacturers of Lead Pipe and Plumbers' Materials. Wholesale Eastern Agents Akron Vitrified Sewer Pipe.

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OTIS ELEVATORS.

They are built by Otis Brothers & Co., 38 Park Row, New York.

TO SEWER CONTRACTORS.

Sealed proposals are invited for the complete construction of a sewer in the city of Morrison, Ill., including all the necessary materials therefor, as per plans, profiles and specifications now on file in the City Clerk's office of said city.

The sewer is known as the "Grape Street Sewer System," and consists of about

1,620 feet of 24-inch sewer pipe;
1,230 feet of 20-inch sewer pipe;
586 feet of 18-inch sewer pipe;
1,108 feet of 15-inch sewer pipe;
110 feet of 12-inch sewer pipe;
386 feet of 10-inch sewer pipe;
336 feet of 9-inch sewer pipe;
716 feet of 8-inch sewer pipe;

6,092;

16 manholes, 10 catch basins and 6 lampholes.

The contractor to give sufficient bonds for the completion of the work, and also to indemnify the city for any and all claims that may arise for labor and materials used in construction, if required.

Each bidder shall furnish samples of the pipe and brick to be used.

All bids to be filed in the office of the City Clerk on or before July 1, 1893.

The city reserving the right to reject any or all bids.

M. V. R. SMITH,
H. R. SAMPSON,
W. H. THACHER,
City Sewer Department.

Morrison, June 13, 1893. 25-2t

COLUMBUS SEWER PIPE CO. COLUMBUS, OHIO.

Write for Prices.

Any company contemplating the expenditure of a large amount in the establishment of a manufacturing industry, requiring the use of a thoroughly equipped Machine shop, Boiler shop, Foundry and Smith shop plant, well located on competing trunk lines on railroads and in a good labor market, is invited to address Stimson, Williams & Co., Bryant Building, 55 Liberty street, New York city.

UNITED STATES ENGINEER OFFICE, Wilmington, Del., June 19th, 1893.—Sealed proposals for dredging and excavating for the construction of an inland waterway from Chincoteague Bay, Va., to Delaware Bay, Del., will be received at this office until 12 o'clock noon, July 18th, 1893, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office.
WM. F. SMITH, United States Agent.
25-4t

PROPOSALS FOR BRICK PAVING.

Sealed bids or proposals will be received by the Common Council of the city of Hornellsville, N. Y., at the Council Rooms in said city, until three o'clock p. m. on Wednesday, the fifth day of July, 1893, for paving with vitrified brick Main street, from the Canacadea Creek to the Canisteo River, in said city.

The approximate amount of work to be done is as follows: Six thousand (6,000) cubic yards of excavation, twenty-five thousand (25,000) square yards of pavement, nine thousand (9,000) lineal feet of curbing, eight thousand four hundred (8,400) lineal feet of 4-in. drain tile, one hundred and eighty (180) lineal feet circular curb corners.

Plans may be examined and specifications and further information obtained at the office of F. A. Dunham, Engineer in Charge, 131 Main St., Hornellsville, N. Y.

A certified check for twenty-five hundred dollars ($2,500) must accompany each bid.

The Council reserves the right to reject any or all bids.

F. A. DUNHAM,
Engineer in Charge.
H. L. NASH, City Clerk. 25-2t

WATER WORKS—TOWN OF MEREDITH, N. H.

Sealed proposals will be received by the Water Commissioners of Meredith Village Fire District, in the town of Meredith, N. H., until 12 o'clock, noon, Thursday, June 30, 1893.

The work will consist of a reservoir of about 5,500,000 gallons capacity, covering about two and four-tenths (2 4-10) acres, and about five miles of pipe, varying in size from four (4) to ten (10) inches, requiring about 550 tons of cast iron pipe and special castings, together with about 30 gates and 33 hydrants.

The earthen dam will be about 300 feet long and about 26 feet high.

Proposals will be received for the above work, in whole or in part.

The contractor will state the time he will require to complete the work.

The Commissioners reserve the right to reject any or all proposals.

Specifications and plans can be seen upon application to the Water Commissioners at Meredith, N. H., or to Samuel M. Gray, Consulting Engineer, 20 Market Square, Providence, R. I. 24-3t

PROPOSALS FOR STEAM TENDERS, quarter boats, etc.—U. S. Engineer Office, Room 430, Custom House, St. Louis, Mo., June 16, 1893.—Sealed proposals, in duplicate, for furnishing 3 steam tenders, 4 quarter boats, 1 office and survey boat, 12 barges, 11 pile drivers, 100 flats, 30 skiffs, and 10 yawls, will be received at this office until 12 m. July 17, 1893, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. CHAS. J. ALLEN, Major, Corps of Engineers. 25-3t

PROPOSALS FOR CONSTRUCTION OF DAMS AND SHORE PROTECTIONS ON UPPER MISSISSIPPI RIVER, AND FOR FURNISHING ROCK AND BRUSH ON UNITED STATES BARGES.—U. S. Engineer Office, Rock Island, Ill., June 3, 1893.—Sealed proposals will be received at this office until two o'clock p. m. on the 6th day of July, 1893, and then publicly opened, for: 1. Furnishing thirty thousand (30,000) cubic yards of brush between St. Paul and Lake Pepin. 2. Furnishing ten thousand (10,000) cubic yards of rip-rap rock between St. Paul and Lake Pepin. 3. Construction of shore protections between Smith's Bar and Lake Pepin. 4. Furnishing twenty-five thousand (25,000) cubic yards of brush between Fountain City and Genoa, Wisconsin. 5. Furnishing ten thousand (10,000) cubic yards of rip-rap rock between Fountain City, Wis., and Brownsville, Minn. 6. Construction of dams and shore protections between Genoa and Prairie du Chien, Wis. 7. Construction of dams and shore protections between Dubuque and Clinton, Iowa. 8. Furnishing thirty thousand (30,000) cubic yards of brush between Keithsburg, Ill., and Montrose, Iowa. 9. Furnishing twenty-five thousand (25,000) cubic yards of rip-rap rock between Keithsburg, Ill., and Montrose, Iowa. 10. Furnishing twenty thousand (20,000) cubic yards of brush between Quincy Bridge and Clarksville, Mo. 11. Furnishing fifteen thousand (15,000) cubic yards rip-rap rock between Hannibal and Clarksville, Mo. 12. Construction of dams and shore protections between Clarksville, Mo., and Hamburg, Ill. 13. Construction of dams and shore protections between Hamburg, Ill., and Cap au Gris, Mo. 14. Construction of dams and shore protections between Cap au Gris, Mo., and mouth of the Illinois River. 15. Furnishing fifty thousand (50,000) cubic yards of brush within twenty-five miles of Piasa Island. Specifications, blank forms, and all available information will be furnished on application to this office. 23-4t

TREASURY DEPARTMENT, OFFICE Supervising Architect, Washington, D. C., June 16th, 1893.—Sealed proposals will be received at this office until 2 o'clock, p. m., on the 12th day of July, 1893, and opened immediately thereafter, for all the labor and materials required for the interior finish and plumbing of the United States Court House and Post-Office at Springfield, Missouri, in accordance with drawings and specification, copies of which may be had at this office or the office of the Superintendent, at Springfield, Missouri. Each bid must be accompanied by a certified check for a sum not less than 2% of the amount of the proposal. The right is reserved to reject any and all bids and to waive any defect or informality in any bid, should it be deemed in the interest of the Government to do so. All bids received after the time stated will be returned to the bidders. Proposals must be inclosed in envelopes, sealed and marked, "Proposal for the Interior Finish and Plumbing of the United States Court House and Post Office, at Springfield, Missouri," and addressed to JEREMIAH O'ROURKE, Supervising Architect. 25-2t

TO BRIDGE CONTRACTORS.

Sealed bids will be received by the Joint Committee of Bergen and Hudson counties, at the Hotel of Edo Vreeland, at Paterson Plank Road Bridge, on July 18, 1893, at 3:30 p. m., for repairing the draw and bulkheads of the Paterson Plank Road Bridge.

Specifications of the work required to be done can be seen at office of Clerk of Bergen County Board of Freeholders, Hackensack, N. J., and at office of Clerk of Hudson County Board of Freeholders, Jersey City, N. J.

J. R. TOLESON, Rutherford, N. J.
26-2t Chmn. Bergen Co. Board.

CATARACT STONE COMPANY,

STONE THE STRONGEST. **STONE THE BEST.**

Heavy Railroad Masonry a Specialty.

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We quarry and dress any dimension stone required from the LARGEST to the smallest.

WORKMANSHIP GUARANTEED.

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CORRESPONDENCE SOLICITED. ADDRESS

CATARACT STONE COMPANY, Clearfield, Pa.

NOTICE TO CONTRACTORS.

Sealed proposals will be received at this office until July 10, at 6 p. m., for the construction of seventy-seven hundred and seventy-five linear feet of Telford Street, for the Borough of Huntingdon, Pa.

To be let in six sections, the Borough furnishing the stone. Each bid must be accompanied by a certified check to the amount of five per cent. of the bid. Specifications and all available information will be furnished on application to this office. The right to reject any or all bids is hereby reserved.

J. MURRAY AFRICA,
Borough Engineer.

Engineer's Office, Huntingdon, Pa., June 23, 1893. 26-2t

TO SEWER CONTRACTORS.

Sealed proposals, properly indorsed, will be received by the undersigned until 12 o'clock (noon) Saturday, July 15, 1893, for constructing sewers, drains and appurtenances in connection with the extension of the Borough sewer system, at which time they will be publicly opened.

The approximate estimate of work to be done as follows:

7,500 cubic yds. of earth excavation in trenches.

7,500 cubic yds. of rock excavation in trenches.

250 cubic yds. of earth excavation in pump well.

120 cubic yds. of concrete masonry.

100 cubic yds. of brick masonry.

100 cubic yds. of rubble masonry.

Also the laying of:

2,055 lin. ft. 24-in. cast iron pipe.

4,000 lin. ft. 20-in. cast iron pipe.

120 lin. ft. 18-in. vitrified pipe.

A certified check for $1,500, payable to the Borough of Stamford, will be required of each bidder as a guarantee that if bid is accepted a contract will be entered into and the performance thereof properly secured.

Plans and specifications of the work may be seen at the office of W. B. Pierce, Borough Engineer, Town Hall, Stamford, Conn. The Borough Board reserves the right to reject any or all proposals.

W. L. BALDWIN, Borough Clerk.

Stamford, Conn., June 24, 1893. 26-3t

SAINT JOSEPH, MICH., SEWERS.

Sealed proposals will be received by the Board of Sewerage Commissioners of the City of Saint Joseph, Mich., until 3 p. m., July 10th, 1893, for the construction of about 12,000 lineal feet of sewers. Plans, specifications and instructions to bidders may be seen at the office of the Board in the City Hall, at Saint Joseph, Mich., or at the office of A. V. Powell, Consulting Engineer, Room 1101, Chamber of Commerce Building, Chicago, Ill.

GEO. E. SMITH,
Secy. Board Sewerage Commissioners.

Saint Joseph, Mich., June 21st, 1893. 26-2t

BRICK AND PIPE SEWERS, NEW ORLEANS, LA.

Sealed proposals will be received by the New Orleans Sewerage Company until noon of July 24th, 1893, for the furnishing of material and the construction of sewers and appurtenances in the City of New Orleans, La. Quantities approximately as follows:

1. Part of Section 3, District Sewers:

1,600 feet of 30-in. single ring brick sewer.

96,000 feet of pipe sewers, sizes from 8 in. to 24 in.

146 manholes.

20 flush tanks.

2. Block A, of main sewer (pumping station to Canal St.), 4,000 feet of brick sewer on concrete cradle, of sizes ranging from 5 ft. 4 in. × 6 ft. 8 in. to 5 ft. 2 in. × 6 ft. 5½ in.

15 manholes.

Bids will be received and considered separately on parts 1 and 2, as above.

Certified checks required to accompany bids will be for part 1, $2,500; and for part 2, $1,000.

Plans can be seen and specifications, forms of proposal, contract and bond and "quantity" and "instructions to bidders" sheets will be furnished at the office of the company, No. 48 Carondelet St., New Orleans, La.

Payments in cash monthly.

The right is reserved to reject any or all bids.

DR. JOSEPH HOLT, President.

GEO. G. EARL, Chief Engineer. 26-4t

PROPOSALS FOR WATER-WORKS.

Sealed proposals will be received by the Board of Directors of the Hanover Water-Works Co., at the building of the Thayer School of Civil Engineering, Hanover, N. H., until Friday, July 14, 1893, at 3 p. m.: Firstly, for the construction of an earth dam (about 16,000 cubic yards), with a core wall, gate chamber and gatehouse, wasteways, etc. Secondly, for laying water pipes and setting special castings, valves, hydrants, etc., for about two miles of main line and about four and a half miles of distribution system, sizes of cast iron pipes varying from 14 inch to 4 inch.

Proposals must be made upon blank forms attached to the specifications, and in sealed envelopes, marked only "Proposals" and addressed to the Hanover Water-Works Co., Hanover, N. H.

Bidders must visit the locality in person and examine all the conditions affecting the work. Proposals must be accompanied by a certified check for two hundred dollars payable to order of the Treasurer of the company, said check to be forfeited to the company in case of failure of the bidder tendering the same to appear with sureties and execute a contract within five days after acceptance of the bid.

The successful bidder will be required to give bond to the amount of $5,000, conditioned upon the faithful performance of each and every specification of the contract. Two of the sureties upon said bond must be owners of real estate in and citizens of New Hampshire.

Lines and locations on the ground and, the engineer's plans will be shown contractors on application to Prof. R. Fletcher, Hanover, N. H. Forms of proposals and specifications furnished on application, as above.

The Hanover Water-Works Co. reserve the right to reject any and all bids, or parts of the same, as in their judgment the interests of the Village Precinct of Hanover may demand.

FRANK W. DAVISON,
ROBERT FLETCHER, Engineer,
FRANK S. STREETER,
Committee of the Board of Directors.

Hanover, N. H., June 27, 1893. 26-1t

TO SEWER CONTRACTORS.

Sealed proposals will be received by the Board of Sewer Commissioners of the city of Pawtucket, R. I., until Friday, July 7th, 1893, at 11 o'clock a. m. for constructing a sewer in West avenue in said city.

The work for which proposals are solicited consists in constructing, with the necessary appurtenances, about 2,700 feet of brick sewer from 22 to 68 inches in diameter; 1,000 feet of pipe sewer from 12 to 18 inches in diameter. Average depth of excavation for brick sewer about 17 feet, for pipe sewer about 10 feet.

Each proposal must be accompanied by a certified check to the amount of $1,000 as a guarantee that if the proposal is accepted a contract will be entered into.

A bond of 20% of the amount of the contract will be required of the successful bidder.

The Board of Sewer Commissioners reserve the right to reject any and all bids.

Plans and specifications may be seen at the office of the Board of Sewer Commissioners, Room 8 Music Hall Building, Main street, Pawtucket, R. I.

Per order of the Board of Sewer Commissioners.

A. R. SWEET, C. E.,
Superintendent.

26-1t

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NOTICE TO CONTRACTORS.

BUILDING SEWERS AND APPURTENANCES.

Sealed proposals for the above work, indorsed with the above title and the name and address of the party making the same and addressed to the Township Committee, will be received at the office of the Township Clerk, Montclair, N. J., until 5 p. m., July 10, 1893.

Plans and sections, proposal blanks and specifications can be seen at the offices of the engineers in charge, James Owen, C. E., Montclair, N. J., and Carrol Ph. Bassett, C. E., Orange, N. J.

The proposal consists of, approximately:

4,965 feet of 24-inch vitrified pipe sewer.

1,960 feet of 18-inch vitrified pipe sewer.

64 feet of manholes more than 12 feet deep.

231 feet of manholes less than 12 feet deep.

The bids will be compared on the basis of the above quantities, and the list of extras filed in the office of the engineer.

Each proposal shall be accompanied by a certified check payable to the inhabitants of the Township of Montclair for $1,000.

Permission will not be given for the withdrawal of any proposal after it is filed wth the Township Clerk.

A bond of a responsible indemnity or guarantee company of or authorized by law to do business in the State of New Jersey, and satisfactory to the Township Committee, or a bond of at least three responsible freeholders of Essex County, who shall signify in writing accompanying the bid their willingness and ability to qualify as bondsmen of the bidder, satisfactory to the Township Committee, in a penal sum equal to 25 per cent. of the total contract price, shall be furnished by the party to whom the contract may be awarded, such bond to be conditioned for the faithful performance of the contract.

The person or persons to whom the contract may be awarded will be required to attend, at the office of the Township Clerk, with the securities offered by him, or them, and execute the contract within ten days from the date of the award; and in case of failure or neglect so to do, he or they will be considered as having abandoned, and as in default to the inhabitants of the Township of Montclair, and the latter shall have the right to re-award the said contract.

The work is to be begun within one month after the contract is awarded by the Township Committee, and in such order as the engineer may direct, and to continue regularly during suitable weather until the entire completion of the contract.

Bidders will state the price in their proposals in writing, as well as figures for each separate item of work, by which the bids will be compared, but each proposal must cover the entire work. The prices are to cover all expenses of furnishing materials, tools, labor, and for completing the work aforesaid in conformity with the contract and specifications prepared for the same.

The proposals must be made on blanks furnished by the Committee, and all proposals will be considered inoperative which are not in all respects in conformity with this notice.

The Township Committee expressly reserves the right to reject any or all proposals.

HENRY L. YOST, Township Clerk.

Montclair, N. J., 1893. 26-2t

FOR JUNE.

What Will the Democrats Do?
A FORECAST OF TARIFF LEGISLATION.
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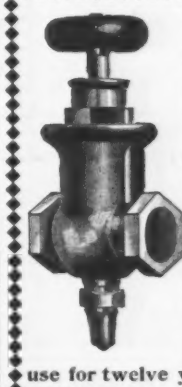

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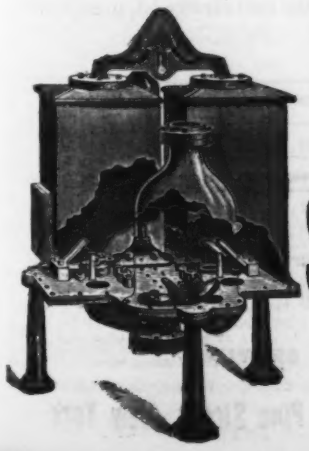

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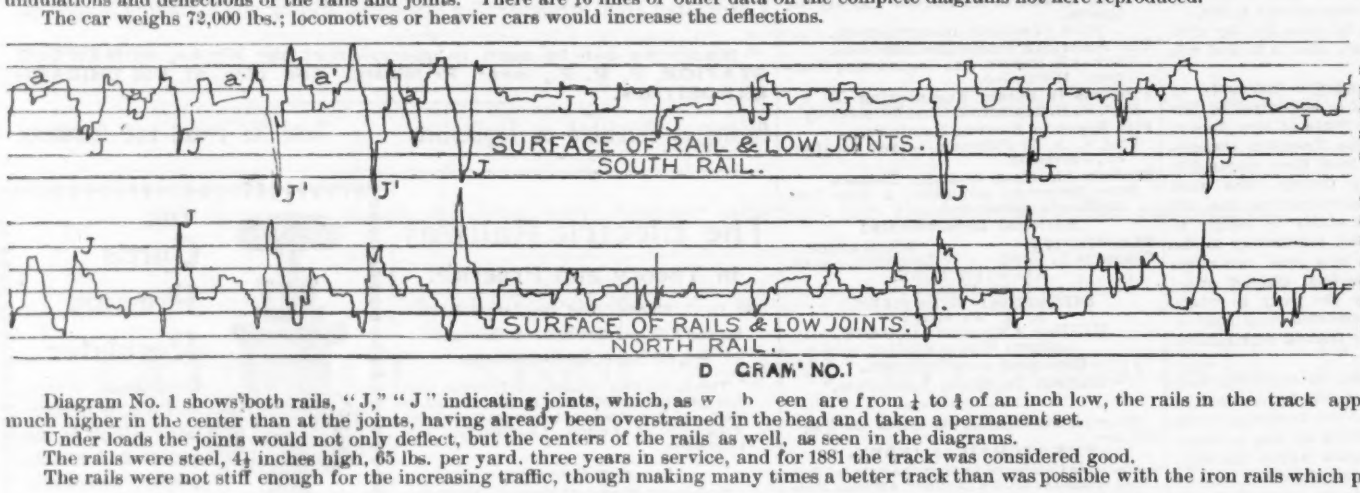
The illustrations are short portions of the original diagrams as taken by my Inspection Car as it runs over the tracks at 20 miles per hour showing the surface undulations and deflections of the rails and joints. There are 16 lines of other data on the complete diagrams not here reproduced.
The car weighs 72,000 lbs.; locomotives or heavier cars would increase the deflections.



The horizontal scale is one inch of paper to 50 feet of track, the vertical scale being full size.
The scale of the diagrams is thus ample to show, not only the bends and deflections of the rails, but whether the surface is smooth or rough or the joints worn.

D GRAM. NO. 1

Diagram No. 1 shows both rails, "J," "J" indicating joints, which, as w b een are from ¼ to ¾ of an inch low, the rails in the track appearing to the eye much higher in the center than at the joints, having already been overstrained in the head and taken a permanent set.
Under loads the joints would not only deflect, but the centers of the rails as well, as seen in the diagrams.
The rails were steel, 4½ inches high, 65 lbs. per yard. three years in service, and for 1881 the track was considered good.
The rails were not stiff enough for the increasing traffic, though making many times a better track than was possible with the iron rails which preceded them.

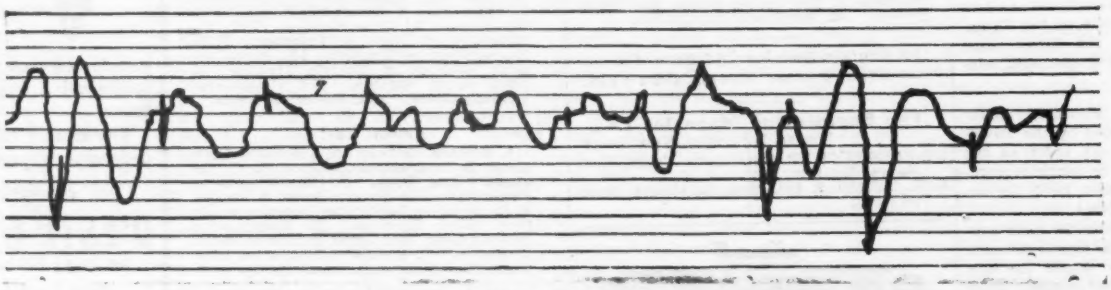


DIAGRAM NO. 2.

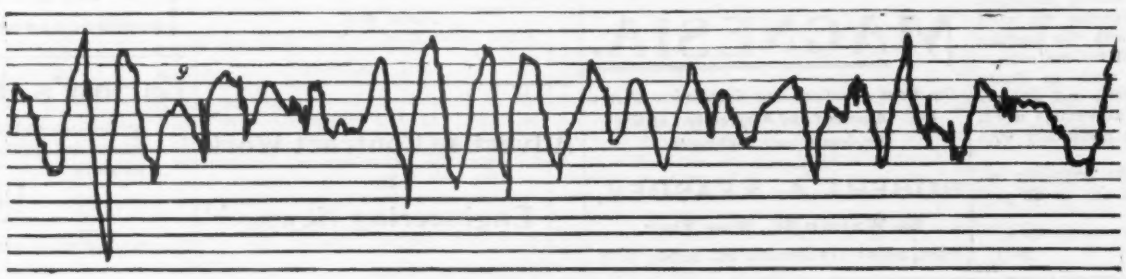


DIAGRAM NO. 3

Diagrams Nos. 2 and 3 of only one line of rails are from 4½-inch 60-lb. steel rails, the first and second years of service respectively; the rails rapidly acquiring bend under modern traffic, become loose on the ties, cutting into them with great rapidity.
Such rails, unless on good hardwood ties like white oak, would remain in surface but a short time.

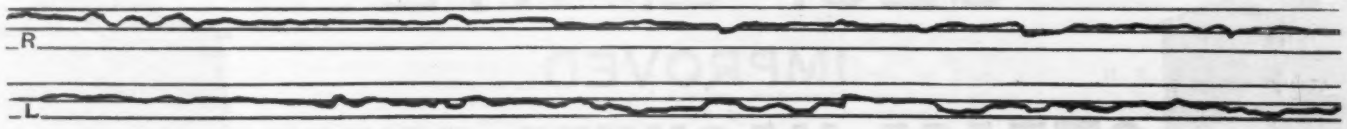


DIAGRAM NO. 4.

Diagram No. 4 is from the Boston & Albany 95-lb. 5-inch rails after 18 months of service, showing a standard of surfacing generally believed impossible, the maximum deflections being under 1-10 of an inch.

Look for an interesting diagram from 18 foot iron rails, chair joints, in next date of issue, July 13, also see issues of April 6, April 20, May 18, May 25, June 15.

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Brown Hoisting and Conveying Co., Cleveland, O.
Hunt Co., C. W., New York.
G. L. Steubner & Co., Long Island City, N.Y.
Link-Belt Machinery Co., Chicago, Ill.

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Case School of Applied Science, Cleveland, O.
Harvard Univ., Cambridge, Mass.
Penn. Military Acad., Chester, Pa.
Rensselaer Polytechnic Inst., Troy, N. Y.
State Shool of Mines, Golden, Colo.
Swarthmore College, Swathmore, Pa.
University of Illinois, Champaign, Ill.
University of Vermont, Burlington, Vt.
Western Univ. of Penn., Allegheny, Pa.

Concrete Mixer.
Cockburn Barrow & Machine Co., Jersey City, N. J.

Contractors (General).
Anderson & Barr, Jersey City, N. J.
Bassett Bros., 208 Main St., Buffalo, N. Y.
Brown, Jas. M., & Co., 115 Broadway, N. Y.
Christie & Lowe, Ashland Blk., Chicago.
Frescoln, S. W., World Bldg., N. Y. City.
Harlow, J. H., & Co., Pittsburg, Pa.
Loss, C. E., & Co., Pullman Bldg., Chicago.
Mains & Lewis, 18 Broadway, N. Y.
McCormick Const. Co. St. Louis, Mo.
Reed & Co., W. S., The Rookery, Chicago.
Remington & Co., Chicago, Ill.
Roosevelt & Sons, Warren, 16 Beaver St., New York.
Sparks & Evans, 436 Walnut St., Phila.
Staats, R. P. & J. H., 29 Broadway, N. Y.
Standard Construction Co., Pittsb'g, Pa.
Woltman, Keith & Co., 11 Wall St., City

Contractors' Machinery.
American Hoist & Derrick Co., St. Paul.
Bucyrus Steam Shovel & Dredge Co., Bucyrus, O.
Carlin's Sons, Thos., Allegheny, Pa.
Claffy, John, 48 Dey St., N. Y.
Contractors' Plant Co., Buffalo, N. Y.
Fairbanks, Morse & Co., Chicago.
Halpin, Wm., 47 Washington St., N. Y.
Ingersoll-Sergeant Rock Drill Co., N. Y.
Iredell, F. W., 10 Park Place, N. Y.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Middleton, W. S., 52 John St., N. Y.
Mundy, J. S., Newark, N. J.
Ryan-McDonald Mfg. Co., Baltimore, Md.
Souther, John, & Co., Boston, Mass.
Toledo F'dry & Mach. Co., Toledo, O.
M. Beatty & Sons, Welland, Ont.

Corrugated Iron.
Canton Steel Roofing Co., Canton, O.

Cranes
Detroit F'dry. Equipment Co., Detroit.

Creosoting.
Carolina Oil & Creosote Co., Wilmington, N. C.
Eppinger & Russell, 160 Water St., N. Y.
Lehigh Valley Creosoting Works, Washington St., Jersey City, N. J.
Old Dominion Creosoting Works, 57 Main St., Norfolk, Va.
Vanderbilt & Hopkins, 120 Liberty St., N.Y.

Damper Regulators.
Standard Thermometer Co., Peabody, Mass.

Diamond Drills.
Sterns Bros., 3357 Atlantic Ave. Brooklyn, N. Y.

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Austin, F. C., & Co., Chicago, Ill.
Beatty, M., & Sons, Welland, Ont.
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Marion Steam Shovel Co., Marion, O.
Osgood Dredge Co., Albany, N. Y.
San Francisco Bridge Co., San Francisco, Cal.; Seattle, Wash., and 183 World Bldg., N. Y.
Souther, John, & Co., Boston.
Toledo Foundry & Machine Co., Toledo, O.
Vulcan Iron Works, Chicago.

Divers.
Falcon, Jos. G., Evanston, Ill.
Knudson & Son, 874 Washtenaw Ave., Chicago, Ill.
Thacher & Breymann, 336 Water St., Toledo, O.

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Morse, A. J., & Son, 140 Congress St., Boston
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Anderson & Barr, Jersey City, N. J.
Atlantic Dredging Co., New York.
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Marion Steam Shovel Co., Marion, O.
Mundy, J. S., Newark, N. J.
Osgood Dredge Co., Albany, N. Y
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Vulcan Iron Works, Chicago, Ill.

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Stow Flexible Shaft Co., Philadelphia.
Stow Mfg. Co., Binghamton, N. Y.
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Engin. Employm. Bureau, Syracuse, N. Y.
Western Engineering Agency, Chicago.

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Otto Gas Engine Works, Philadelphia, Pa.

Engines (Hoisting).
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Bucyrus Steam Shovel & Dredge Co., Bucyrus, O.
Carlin's Sons, Thos., Allegheny, Pa.
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Industrial Works, Bay City, Mich.
Iredell, F. W., 10 Park Pl., N. Y.
Lidgerwood Mfg. Co. 96 Liberty St., N. Y.
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Ryan-McDonald Mfg. Co., Baltimore, Md.

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D'Este & Seeley Co., Boston, Mass.

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Ohio Sewer Pipe Co., Pittsburg, Pa
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Sharon Clay Mfg. Co., Sharon, Pa.
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Flush Tank Co., Chicago., Ill.

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Union Switch, & Signal Co., Swissvale, Pa.
Weir Frog Co., Cincinanti, O.

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Standard Thermom. Co., Peabody, Mass.

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Howard-Harrison Iron Co., St. Louis.
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Ohio Sewer Pipe Co., Pittsburg, Pa.
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Pipe Laying (Contractors).
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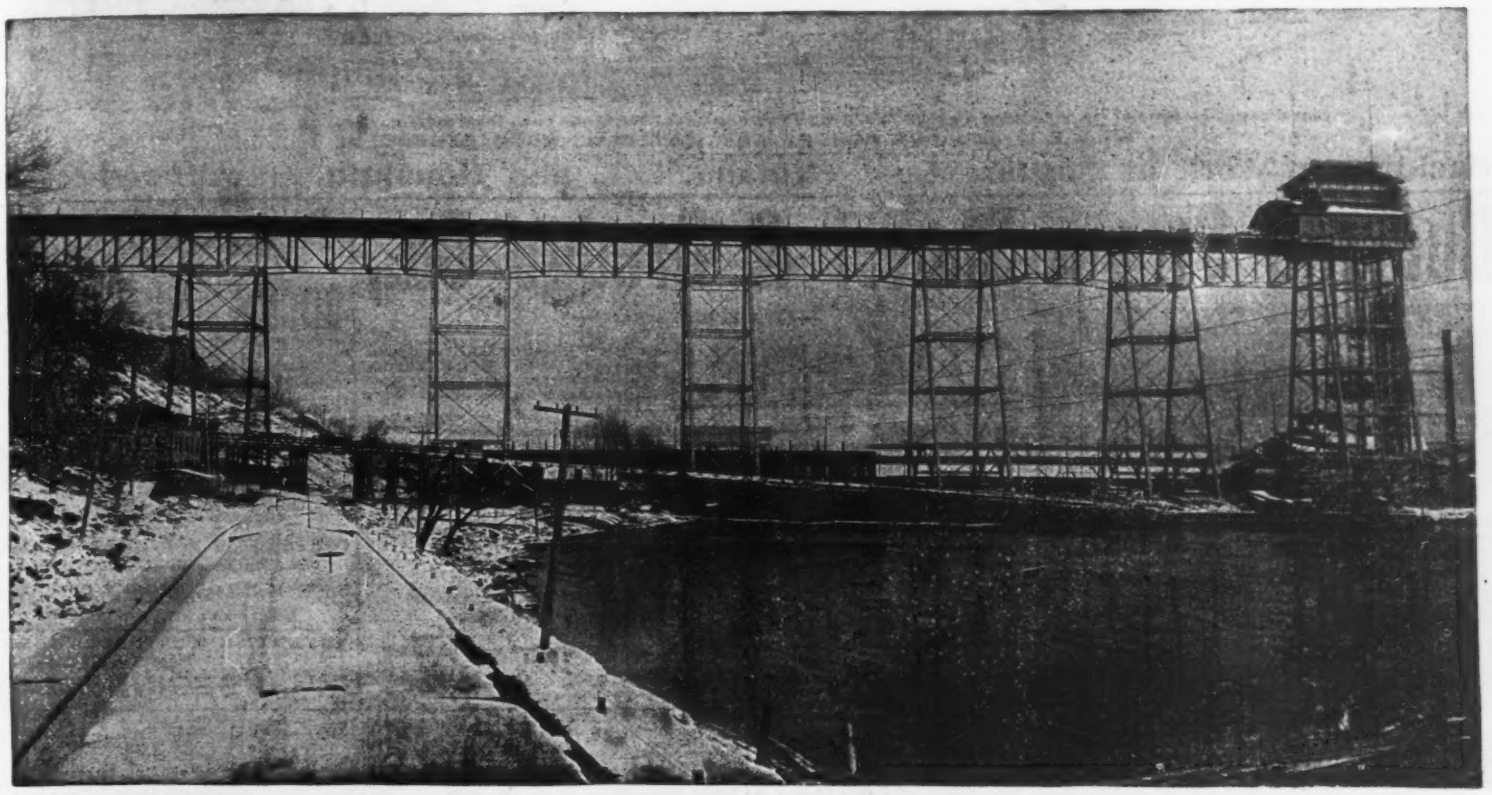

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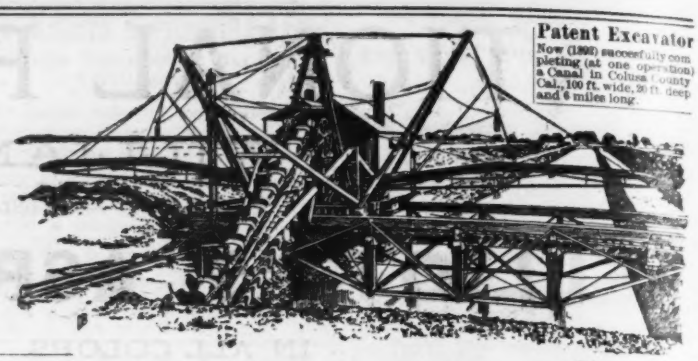

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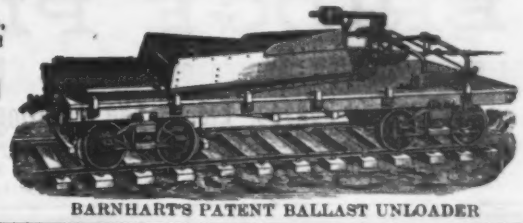

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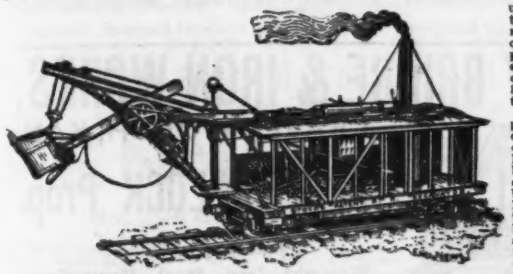

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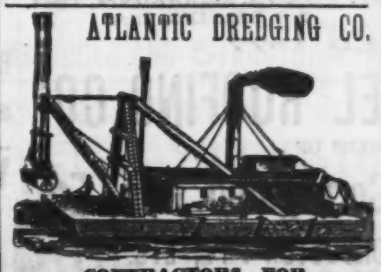

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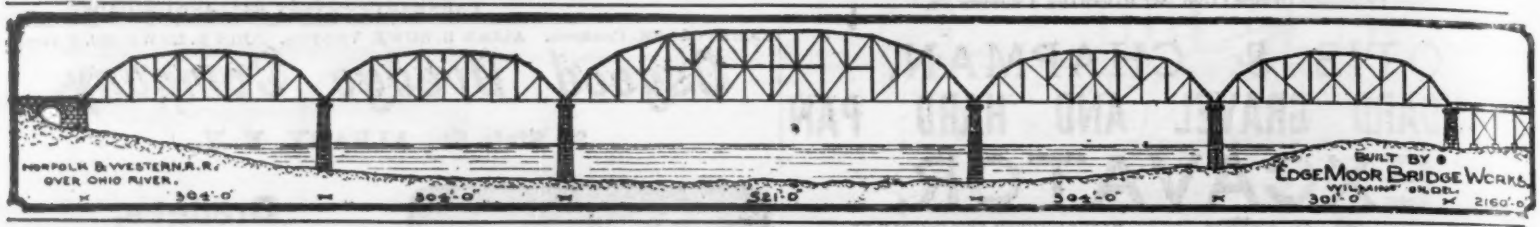

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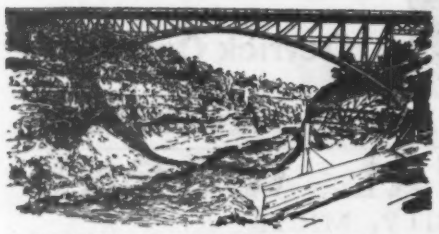

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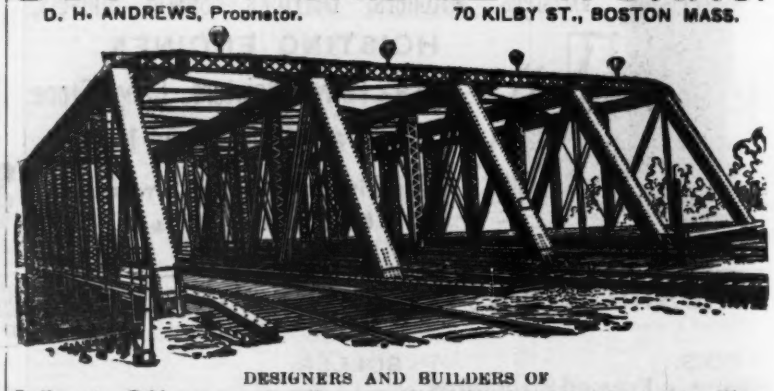

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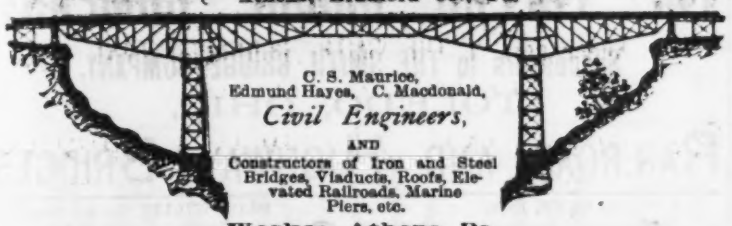
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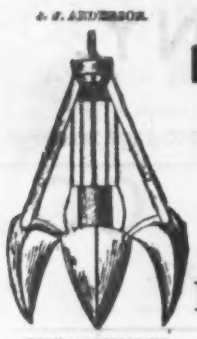

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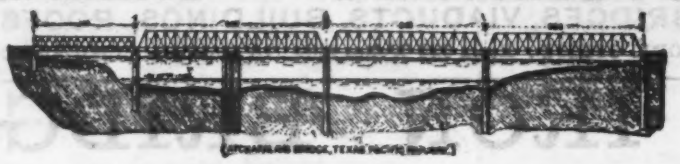

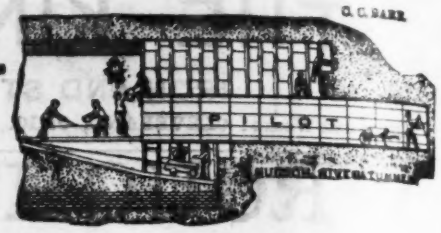

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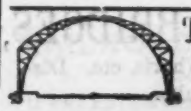

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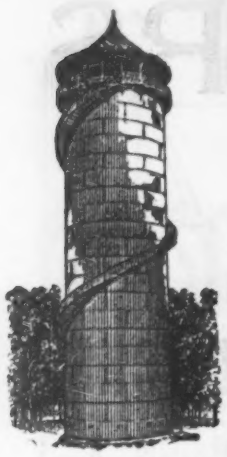

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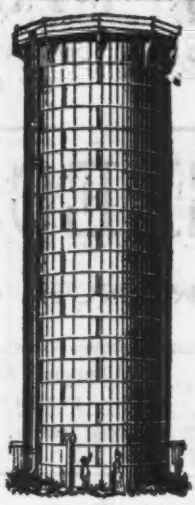

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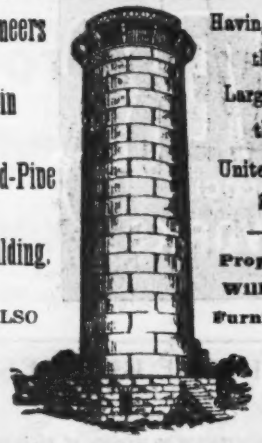

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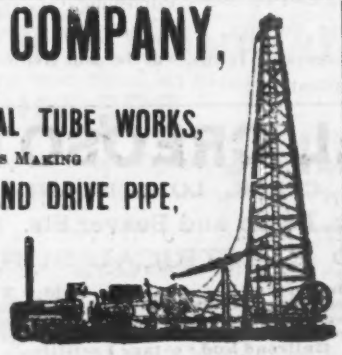

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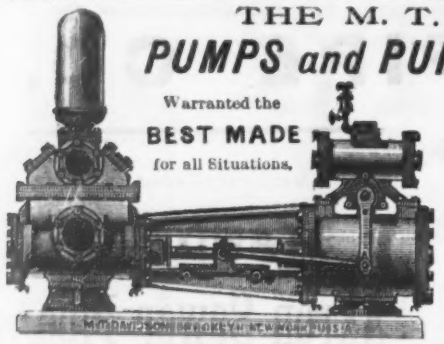

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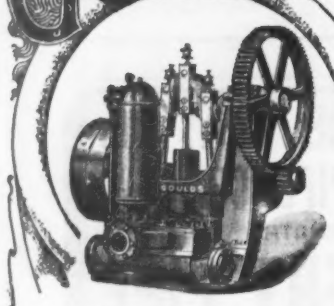

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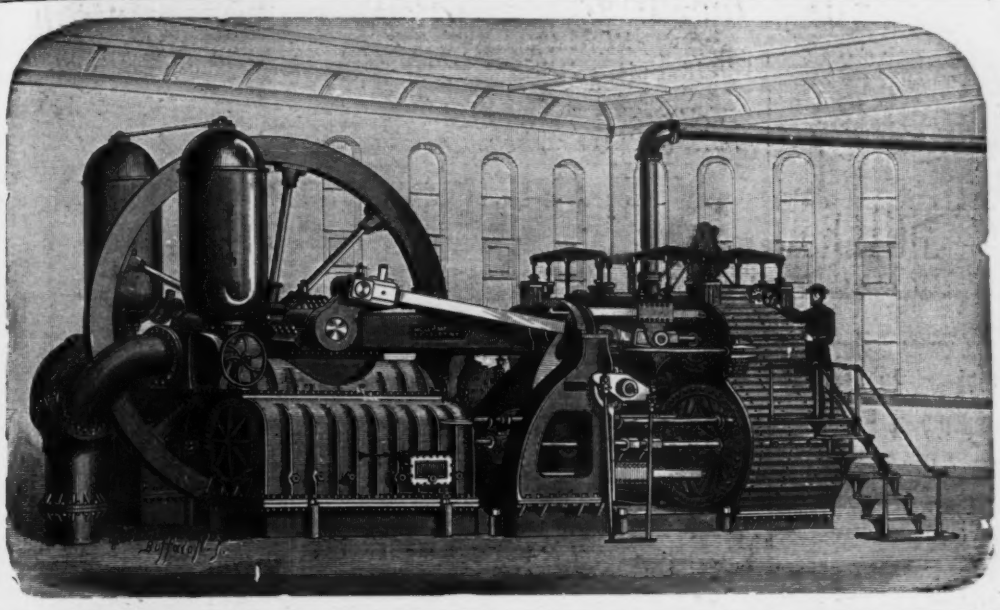

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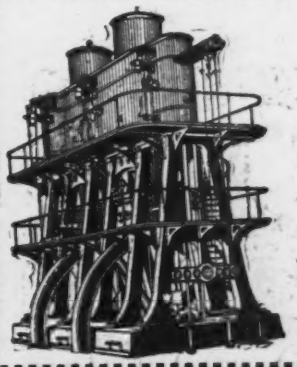

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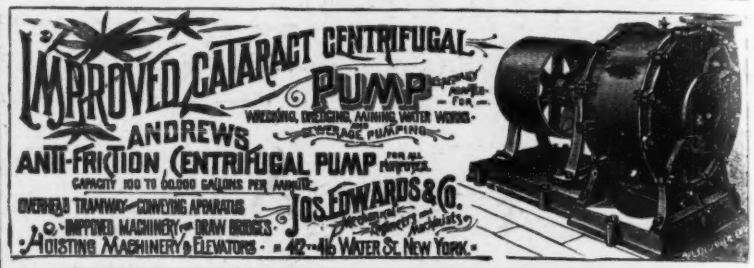
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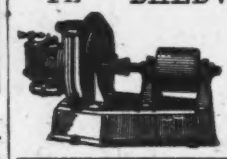

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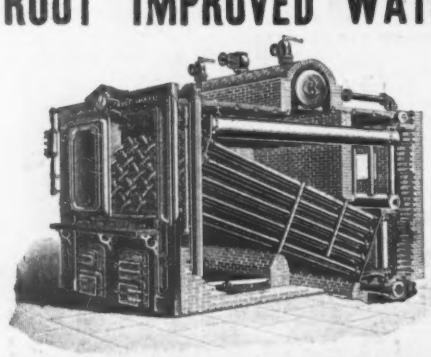

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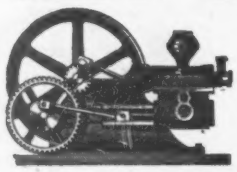

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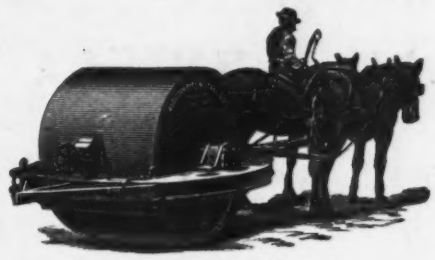

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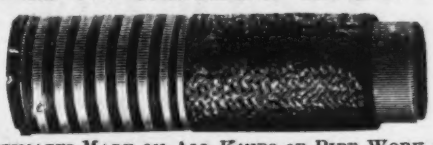

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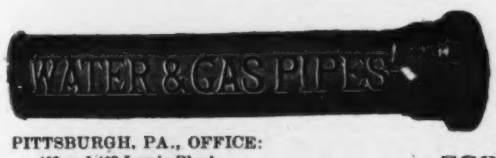

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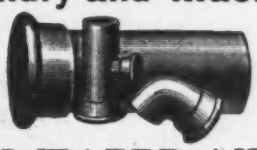

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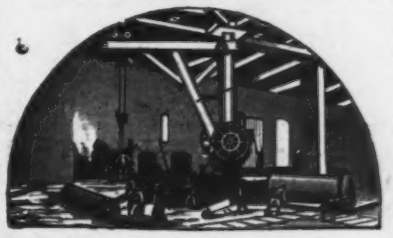

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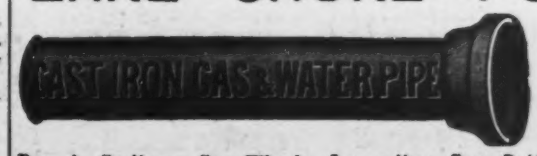

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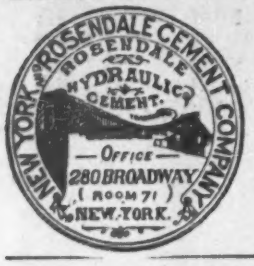

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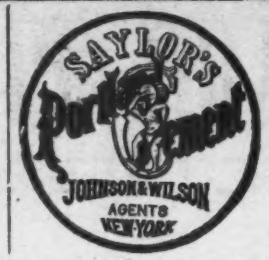

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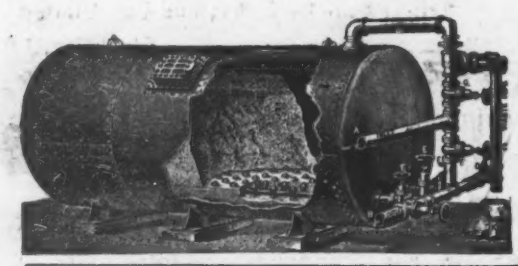

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